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Overview Of Different Routing Techniques For Wireless Multimedia Sensor Network

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Abstract- The area of wireless multimedia sensor networks (WMSNs) is one of the emerging and fast growing fields in the scientific world. This has brought about developing low cost, low-power and multi-function multimedia sensor nodes networks of wirelessly interconnected that are able to ubiquitously retrieve multimedia content such as video and audio streams, still images, and scalar sensor data from the environment. However, the major fact that multimedia sensor nodes run out of energy quickly has been an issue and many energy efficient routing protocols have been proposed to solve this problem and preserve the life time of the network. This is the reason why routing techniques in wireless multimedia sensor network focus mainly on the accomplishment of power conservation. Most of the recent publications have shown so many protocols mainly designed to minimize energy consumption in sensor networks. This paper focuses on the review of such routing techniques used in wireless multimedia sensor network.

Keywords- Wireless multimedia sensor networks (WMSNs), Cluster Head (CH), routing protocols, Base Station (BS) and power.

I. Introduction

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

II. Overview of Routing Techniques

A. DSDV & AODV

Adel.S.El ashheb, [11] compared two routing protocols named DSDV and AODV under specific scenarios with WSNs environment. DSDV and AODV are evaluated in respect of packet delivery fraction, end to end delay and average throughput. Under packet delivery fraction, AODV has better performance than DSDV in the scenarios. PDF increases with an increase in the pause time for both protocols. As far as throughput is concerned, AODV performs by far better compared to DSDV. Average throughput in both protocols decreases steadily with an increase in the number of expired nodes and in case of pause time, the average throughput increases with increasing pause time. AODV suffers from delay. Regardless of the period of pause time, it shows longer average end-to-end delay in comparison with DSDV in the considered scenarios. However, the time delay fluctuates in DSDV protocol with an increase in pause time. On the other hand, end-to-end delay increases in AODV with increasing pause time. However, the results reveal that there is no one protocol which is better than the other. Each protocol has its own advantages as well as its disadvantages making it suitable for some applications and not for others. Hence, an efficient routing protocol should be selected that suits the desired sensing task.

B. HLEAR

So far different routing protocols have been proposed for efficient data communication in WSNs but WMSNs needs special attention because multimedia data require greater bandwidth and memory, constant data transmission, greater power and low latency. The routing algorithm for WSNs is designed for routing small amount of scalar data for relatively short interval of time. Commonly, WSNs routing protocol are established based on min hops, max available power and low latency, low traffic load, multipath establishment etc. Hole creation is another important issue in sensor networks. Nodes near sink are frequently used in routing. As a result their batteries are depleted much earlier. Thus they cannot transfer sensor information to the base station [1].

For this reason a novel routing protocol for WMSNs named Hop and Load based Energy Aware Routing protocol (HLEAR) has been developed by Ayesha Nayyar. In this a protocol HLEAR for wireless multimedia networks is developed which find disjoint or partially disjoin paths based on hop counts, node energy and traffic load. The protocol's performance is compared with Tiny AODV as both are On Demand protocols. HLEAR demonstrated intelligence in its path selection as it selects only those paths which are capable of affording traffic rate and have lesser hop distance. Moreover, with the incorporation of node energy HLEAR is also capable of avoiding the creation of network holes.

C. LEAR

Ayesha Nayyar [8] and his team first developed LEAR protocol to solve the lack of energy in multimedia sensor networks. Where, when an event occurs a RREQ message is sent by the source node for transmitting data which is broadcasted to all the nodes in its range. The nodes receiving this RREQ broadcast this RREQ to other nodes in its range, if it is not the destination. In order to distinguish data types, a bit is designated in the RREQ message. If the bit is set, the data is multimedia and if not it is a scalar data. For scalar data the route discovery is preceded in a normal AODV fashion. If the bit is set, the data needs to be catered in special manner. This is because multimedia data needs more bandwidth, energy and memory space. The destination responds by sending RREP message to the source. When the source receives the RREP message, it sends data along this path. This route is established on the basis for route selection factor β. The node with maximum value of β is selected as best possible node for participating in node and back pointer from this node is created towards the sender.

A node may receive multiple copies of the same RREQ message. The additional RREQ messages must be discarded in order to avoid flooding which can cause network congestion. The RREQ from the nodes having highest β value is accepted and RREQ from all other nodes are dropped. Also node's own RREQ is discarded with any β calculation. This β value calculation helps the node to filters nodes with least number of active routes (network load) and maximum power for next hop in a route by using β value. Hence the base station (destination/sink) does not need to do any type of analysis for path selection.

In case a node's power reaches 25% of its total power, LEAR label this node as "swap node". The swap node is a node that has its power at a critical level. This node do not takes part in routing. The remaining power of swap node is used for data transmission in certain critical conditions. Hence network with minimum number of holes is available. The route discovery process is shown in figure 1 & Table 1 shows the respective routing table.

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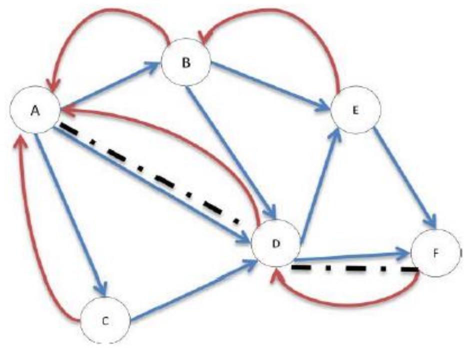

Figure 1: Route discovery process with single source node

Node C will also send RREQ to D and A. Node D will receive multiple copies of the same RREQ from B, C and A. A will also listen to its own generated RREQ. It will calculate β for all of the senders of the RREQ in the same manner. The node having highest β value is selected for RREP and back pointer is created. Node E and F will calculate β values for each of the respective forwarder of RREQ and hence path is selected for RREP.

Table 1: Routing Table with One Source Node

SENDER	RECIEVER	βmax
A	B,D,C	A
A,B,C	D	A
B,E	E	B
D,E	F	D

When two source nodes are sending data at same time, the RREQ message for each source is treated in independent of each other and is identified by their source request ID. The figure 2 shows the network topology with multiple source nodes is shown below. The respective routing table is shown in table 2.

Table 2: Routing Table with Two Source Nodes

SENDER	RECIEVER	βmax
A	B,D,C	A
A,B,C	D	A
B,E	E	B
D,E	F	D
X	C	X
C	A,D	C
A	B	A
D,B	E	B
E,D	F	D

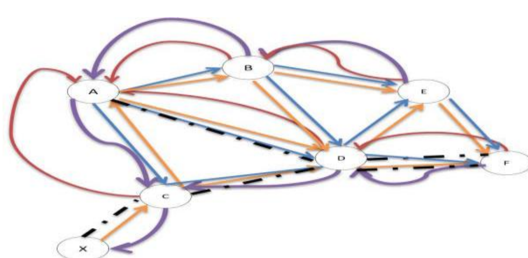

Figure 2: Route discovery process with two source nodes

D. Slot-Management Energy Aware Routing

P. Vanaja Ranjan [2] has simulated SMEAR using ns2 simulator and results are compared with those of without SMEAR. Simulation results show that the packet reception ratio, energy consumption and number of packets received at the sink are much better in a network using SMEAR than that using without SMEAR.

WSNs generally use MAC protocols that are either TDMA based or contention-based. In contention-based protocols, multiple nodes may access the medium simultaneously, resulting in collision. The MAC protocol then provides a mechanism to resolve collision. A TDMA-based energy efficient integrated MAC and routing, called Slot Management based Energy Aware Routing (SMEAR), which provides deterministic delay guarantee. Traditional TDMA MAC protocols suffer from high latency

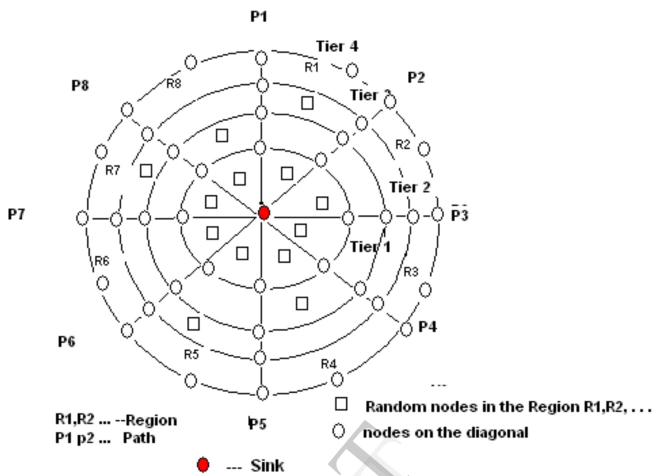

Figure 3: Circular Topology for SMEAR

In SMEAR, each node has known its own route path for transmitting. When the energy of any one path has drained, it automatically selects the next path for transmitting. This ensures that the longevity of the network lifetime. Further, SMEAR nodes could sleep whenever they are not communicating (neither transmitting nor receiving), and hence, it conserves energy. Since SMEAR can provide delay guarantee, it is suitable for real-time applications. This paper presents the method by which time slots are assigned to the path route and show how the slots are reused by paths that are non-interfering. It showed that SMEAR outperforms in terms of energy consumption, number of packets received at the sink and Packet Reception Ratio.

E. EARQ

EARQ is a novel routing protocol for wireless industrial sensor networks [3]. It provides real-time, reliable delivery of a packet, while considering energy awareness. In EARQ, a node estimates the energy cost, delay and reliability of a path to the sink node, based only on information from neighboring nodes. Then, it calculates the probability of selecting a path, using the estimates. When packet forwarding is required, it randomly selects the next node. A path with lower energy cost is likely to be selected, because the probability is inversely proportional to the energy cost to the sink node. To achieve real-time delivery, only paths that may deliver a packet in time are selected. To achieve reliability, it may send a redundant packet via an alternate path, but only if it is a source of a packet.

EARQ is a kind of proactive routing protocol that aims to maintain an ongoing routing table. As in other kinds of proactive routing, EARQ constructs and maintain a routing table with information from neighboring nodes. A beacon message is used to exchange information related to routing among neighboring nodes. The actual path is decided while transmitting a packet.

There are two types of messages: beacon messages and data packets.

A beacon message is exchanged among neighboring nodes to construct and maintain a routing table. Upon receiving a beacon message, a routing table is constructed or updated by calculating expected values of energy cost, delay and reliability. When a path to the sink node becomes known to a node, the node begins to send a periodic beacon message.

The source node sends data packets to the sink after constructing the routing table. Each intermediate node forwards a data packet to a neighboring node that can deliver the packet in time. A neighboring node for forwarding a packet is selected based on the expected delay and probability. This probability is inversely proportional to the expected energy cost of neighboring nodes. Therefore, a path that may expend less energy than other paths is most likely to be selected. To ensure reliable packet delivery, if the expected reliability of the selected node does not satisfy the required reliability, the source node selects an additional neighboring node to forward the packet.

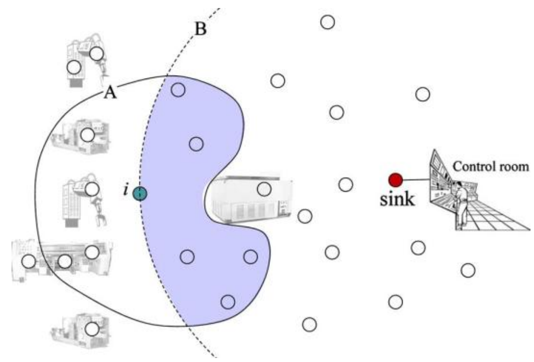

Figure 4: Neighboring nodes in Routing Table of node *i* in WISNs for manufacturing machines.

F. *MANET*

Performance Analysis of MANET Routing Protocols for Multimedia Traffic is presented by Chhagan Lal [7]. The author presents a comparative analysis of mobile ad-hoc routing protocols over real time video streaming. Analysis exploits the built-in support for real time multimedia streaming in ad-hoc routing protocols. The performance evaluation has been based on various network level metrics, including average end-to-end delay and packet drop rate. The performance evaluation results show that transmitting multimedia traffic using traditional MANET routing protocols alone is not sufficient to provide acceptable QoS to end users.

For applications that require very strict QoS guarantees like video conferencing, some sort of QoS support is needed in MANETs. Multimedia streaming has low inter-packet time and large packet size variation. Thus, some sort of adaptation scheme is required to match the transmission speed of a node and channel bandwidth. A suitable admission control scheme is also required to admit a multimedia session on availability of path with sufficient resources without affecting ongoing connections. Furthermore, despite the fact that the problem of accurate estimation of available network resources in MANET is NPInternational hard, a cross-layer scheme with minimum signaling overhead is required.

G. *CLUSTERING*

Clustering is a method by which sensor nodes are hierarchically organized on the basis of their relative proximity to each other. Hierarchical (sensor nodes clustering) energy consumption creates an effective and reliable means of routing collected data from the physical environment, through the sensor nodes to the BS. Clustering of sensor nodes helps to compress the routing table such that the discovery mode between sensor nodes is done more easily. Clustering can also conserve communication bandwidth because it limits the scope of inter-cluster interactions to CHs and avoids redundant exchange of messages among sensor nodes. Each sensor node performs a route table look up for the CH in its region and then routes its collected data to the CH. The CH performs a route discovery estimation based on shortest distance to a recipient CH closer to the BS or directly to the BS. In order to maintain the routing table, link information is exchanged from time to time between sensor nodes to adapt to the change in energy requirement for data transmission by all nodes.

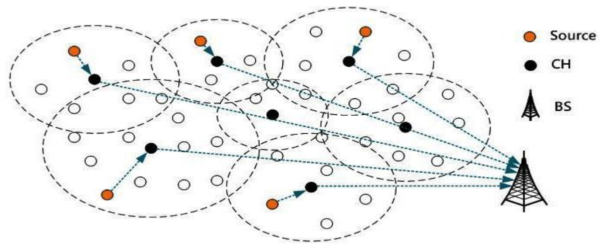

Figure 6: Clustering in WMSN

III. DISCUSSION

All the routing techniques show some of the benefits for saving energy of the batteries in WMSN. Energy-efficient techniques for associating time and spatial coordinates with data to support collaborative processing are also required. Self-configuration and reconfiguration is essential to lifetime of unattended systems in dynamic and constrained energy environment. This is important for keeping the network up and running. As nodes die and leave the network, update and reconfiguration mechanisms should take place. A feature that is important in every routing protocol is to adapt to topology changes very quickly and to maintain the network functions.

EARQ provides efficient, reliable communication, because it only sends a redundant packet via an alternate path if the reliability of a path is less than a predefined value. It selects a path that expends less energy than others, among paths that deliver a packet in time. AODV performs much better where the data packets need to be sent over some unfeasible areas or serious network congestions. Where delay time is not important and the message needs to be guaranteed to arrive at its destination DSDV would be preferred. HLEAR demonstrated intelligence in its path selection as it selects only those paths which are capable of affording traffic rate and have lesser hop distance. MANETs require for the applications that are very strict to provide QoS guarantees like video conferencing, multimedia streaming has low inter-packet time and large packet size variations. Clustering method is used to provide more end-to-end network throughput & better performance by using less energy than a network without such a scheme. Clustering maximize network lifetime in Wireless Sensor Networks (WSNs) the paths for data transfer are selected in such a way that the total energy consumed along the path is minimized. To support high scalability and better data aggregation.

IV. CONCLUSION

The emergence of WMSNs in supporting wide variety of applications is motivating the researchers to do more research on the routing protocols. The common objective is to provide guarantee using energy conserving strategies. In this paper, a comprehensive review on research challenges and the state-of-the art of energy-aware routing techniques for WMSNs, and highlight the advantages and performance issues of each routing protocol and algorithm. Finally, open issues are provided in order to stimulate more research interests in those unexplored areas. It is doubtless that being blessed by the growing advancement of hardware technology, WMSNs will reveal as a powerful technology in near future. So, developing efficient routing protocols for WMSNs appears to be a promising direction of future research.

In routing of packets in wireless sensor networks, some sensor node energy is wasted on relaying others data instead of using its energy own data. Therefore, limiting the energy of the nodes that has little or no energy is another area of future research. One can also take account the communication cost and its impact on network lifetime.

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