REVIEW ARTICLE OPEN ACCESS

Mobile Relay Configuration in Data-Intensuive Wireless Sensor with Three Routing Protocols to Mobile Nodes Networks

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Abstract:-
Wireless sensor network are increasingly used in data-intensive applications such as micro-climate monitoring, precision agriculture and audio/video surveillance. A key challenges faced by data-intensive wsn's is to transmit all the data generated with an application's lifetime to the base station despite the fact that sensor nodes have limited power supply. We propose using low-cost disposable mobile really and our work in the following aspects First, it does not require complex motion planning of mobile nodes. Second we integrate the energy consumption due to both mobility and wireless transmission. Our framework consists of first algorithm computes an optimal routing tree. The second, we integrate the energy consumption due to both mobility and wireless transmissions .The second algorithm improves the topology of the routing tree by greedily adding new nodes. The third algorithm improves the routing tree by relocating its nodes without changing its topology. Frequently forming a network topology without the use of any existing network infrastructure. We compare the performance of the three prominent routing protocols for the mobile relay is Adhoc on Demand Distance Vector (ADVO), Destination Sequenced Distance Vector (DSDV) and Temporally Ordered Routing Protocols (TORA). We have chosen four performance metrics such as Average Delay, Packet Delivery Fraction, Routing load and varying Mobility nodes, simulation for the popular routing protocols AODV, DSDV, and TORA. The simulation is carried out on NS-2. The performance differentials are analyzed using varying network size and simulations times. The simulation results confirm that ADVO performs well in terms of Average Delay, Packet Delivery Fraction. As far as routing load concers TORA performs well.

Index terms- Wireless sensor networks, energy optimization, mobile nodes, wireless routing, Ad-hoc Network, Average Delay, Performance Analysis, Routing Protocols, simulation.

I. Introduction

WSNs have been deployed in a variety of data intensive application including micro-climate and habitual monitoring, precision agriculture, and audio/video surveillance. A moderate-size WSN can gather up to 1 GB/year from a biological habit. Due to the limited storage capacity of sensor nodes, most data must be transmitted to the base station for archiving and analysis. However, sensor nodes must operate on limited power supplies such as batteries or small solar panels and a key challenge faced by data-intensive WSNs is to minimize the energy consumption of sensor nodes so that all the data generated within the lifetime can be transmitted to the base station. Approaches have been proposed to significantly reduce the energy cost of WSNs by using the mobility of nodes. A robitic unit may move around the network and collect data from static nodes through one-hop or multi-hop transmissions. The mobile node may serve as the base station or a "data mule" that transport the data between static nodes and the base station the network also represents a system of wireless mobile nodes that can freely and dynamically self-organize in to arbitrary and temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. Each nodes in the network also acts as a router, forwarding data packets for other nodes. A central challenges in the design of ad hoc network is the development of dynamic routing protocols that can efficiently find routers between two communicating nodes. An ad hoc routing protocol is convention or standard that controls how nodes comes to agree which way to route the packet between computing devices in the mobile ad hoc network MANET to carry out a systematic performance study of three routing protocol for ad hoc networks Ad hoc On Demand Distance Vector (AODV), Destination Sequenced Distance Vector (DSDV), and Temporally Ordered Routing Algorithm (TORA).

II. Related Work

First, the movement cost of mobile nodes is not accounted for in the total network energy consumption. Instead, mobile nodes are often assumed in existing solution which introduces significant design complexity and manufacturing costs. In this paper, we use low-cost disposable mobile relays to reduce the total energy consumption of data intensive WSNs. Different from mobile base station or data mules, mobile relays do not transport data; instead, they move to different locations and then remain stationary to forward data along the paths from the source to the base station and we defined a new mobility metric, which measures mobility in terms of relative speeds of the nodes rather than absolute speeds and pause times. This metric is intended to capture and quantify the kind of node motion relevant for an ad hoc routing protocol. Throughput, Delay and routing load were examined for 50-node network for three routing protocols namely AODV, DSDV and DSR. They used ns-2 based simulation environment. Their findings reveal that DSR was more effective at low load while AODV was more effective at higher loads. They kept small packet size (64bytes). In their simulation, a network size of 50 nodes, 10 to 30 traffic sources, seven different pause times and various movement patterns were chosen. They used ns-2 discrete event simulator. Through simulation, they reached the conclusion that performance of DSR was good at all mobility rates and speeds. AODV produces more routing overhead than DSR at high rates of node mobility.

Comparison of two on demand routing protocols namely, AODV and DSR. They carried out simulation using the ns-2 simulator. This simulator supports an IEEE 802.11 MAC layer, a radio model similar to Lucent's Wave LAN radio interface and a random waypoint mobility model in which pause time was varied from 0 to 900 seconds. Two different scenarios were considered. Different performance metrics were computed for both the protocol. In this paper, we use low-cost disposable mobile relays to reduce the total energy consumption of data intensive WSNs. Different from mobile base station or data mules, mobile relays do not transport data; instead, they move to different locations and then remain stationary to forward data along the paths from the sources to the base station. The behaviour of different routing protocols on network topology changes resulting from link breaks, node movement, etc. In his paper performance of routing protocols was evaluated by varying network sizes, number of nodes.

III. Problem Definition

3.1 Energy Consumption Models

Nodes consume energy during communication, computation, and movement, but communication and mobility energy consumption are the major cause of battery drainage. Radios consume considerable energy even in an idle listening state, but the idle listening time of radios can be significantly reduced by a number of sleep scheduling protocols or we use TORA. In this work, we focus on reducing the total energy consumption due to transmissions and mobility. Such a holistic objective of energy conservation is motivated by the fact that mobile relays act the same as static forwarding nodes after movement.

For mobility, we consider wheeled sensor nodes with differential drives such as Khepera, Robomote and FIRA. This type of node usually has two wheels, each controlled by independent engines. We adopt the distance proportional energy consumption model which is appropriate for this kind of node. The energy EM (d) consumed by moving a distance d is modelled as:

$$EM (d) = kd$$

The value of the parameter k depends on the speed of the node. In general, there is an optimal speed at which k is lowest. In, this we discuss in detail the variation of the energy consumption with respect to the speed of the mote. When the node is running at optimal speed, $k = 2$.

To model the energy consumed through transmissions, we analyze the empirical results obtained by two radios CC2420 and CC1000 that are widely used on existing sensor network platforms. For CC2420, the authors of studied the transmission power level needed for transmitting packets reliably (e.g., over 95% packet reception ratio) over different distances. Let ET (d) be the energy consumed to transmit reliably over distance d. It can be modelled as

$$ET (d) = m (a + bd2)$$

Where m is the number of bits transmitted and a and b are constants depending on the environment. We now discuss the instantiation of the above model for both CC2420 and CC1000 radio platforms. In an outdoor environment, for received signal strength of -80 dbm (which corresponds to a packet reception ratio higher than 95%), we obtain $a = 0.6\times10-7$J/bit and $b = 4 \times 10-10$Jm−2/bit from the measurements on CC2420. This model is consistent with the theoretical analysis discussed. We also consider the energy needed by CC1000 to output the same levels. We get lower consumption parameters: $a = 0.3 \times 10-7$J/bit and $b = 2 \times 10-10$Jm−2/bit. We will see in Section 5 that we maintain this high packet reception ratio throughout our algorithm. We note that although the mobility parameter k is roughly 1010 times larger than the transmission parameter b, the relays move only once whereas large amounts of data are transmitted. For large enough data chunk sizes, the savings in energy transmission costs compensates for the energy expended to move the nodes resulting in a decrease in total energy consumed.

IV. Protocol Description

4.1 Routing protocols for ad-hoc networks

The routing protocols are proactive in that they maintain routes to all nodes, including nodes to which no packets are sent. They react to topology changes, even if no traffic is affected by the change. They are based on either link-state or distance vector principles and require periodic control messages to maintain routes to every node in the network. An alternative approach is reactive route establishment, where routes between nodes are determined only when explicitly needed to route packets. Three routing protocols are studied in this work, namely Ad-hoc on Demand Distance Vector (AODV), Destination Sequenced Distance Vector (DSDV), and Temporally Ordered Routing Protocol (TORA).

4.1.1 Ad Hoc on Demand Distance Vector Routing – AODV

The AODV routing protocol shares features of both DSDV and DSR algorithms. AODV shares DSR's on-demand characteristics in that it also discovers route as and when needed by initiating a route discovery process. It maintains one entry per destination in its routing tables unlike in DSR, which maintains multiple route entries for each destination in its route cache. In AODV, the packets carry the destination address and sequence number. In AODV, when a source requires a path to the destination, a route request (RREQ) message is flooded in the network. When an intermediate node receives such a RREQ, it examines its local route cache to check whether a fresh route to the required destination is available or not. If a fresh route exists, then the node unicasts a route reply (RREP) message immediately back to the source. As an optimization, AODV uses an "expanding ring" flooding technique, where a RREQ is issued with a limited TTL only. If no RREP message is received within a certain time by the source node, then another RREQ is issued with a larger TTL value. If still no reply, the TTL is increased in steps, until a certain maximum value is reached. During route discovery process, all IP-Packets generated by the application for destination are buffered in the source node itself. When a route is established, then the packets are transmitted. An important feature of AODV is the maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is said to be expired if not used within certain duration. These nodes are notified with route error (RERR) packets when the next-hop link breaks. In the situation of link break, each predecessor node, forwards the RERR to its own set of predecessors. In this way all routes, which contain the broken link, are removed.

4.1.2 Destination Sequenced Distance Vector – DSDV

DSDV is a hop-by-hop distance vector routing protocol. It is proactive; each network node maintains a routing table that contains the next-hop for, and number of hops to, all reachable destinations. Periodical broadcasts of routing updates attempt to keep the routing table completely updated at all times. To guarantee loop-freedom DSDV uses a concept of sequence numbers to indicate the freshness of a route. A route R is considered more favourable than R' if R has a greater sequence number or, if the routes have the same sequence number, R has lower hop-count. The sequence number for a route is set by the destination node and increased by one for every new originating route advertisement. When a node along a path detects a broken route to a destination D, it advertises its route to D with an infinite hop-count and a sequence number increased by one. Route loops can occur when incorrect routing information is present in the network after a change in the network topology, e.g., a broken link. In this context the use of sequence numbers adapts DSDV to a dynamic network topology such as in an ad-hoc network. DSDV uses triggered route updates when the topology changes. The transmission of updates is delayed to introduce a damping effect when the topology is changing rapidly. This gives an additional adaptation of DSDV to ad-hoc networks.

4.1.3 Temporally Ordered Routing Algorithm – TORA

The TORA is a highly adaptive loop-free distributed routing algorithm based on the concept of link reversal. TORA is proposed to operate in a highly dynamic mobile networking environment. It is source-initiated and provides multiple routes for any desired source/destination pair. The key design concept of TORA is the localization of control messages to a very small set of nodes near the occurrence of a topological change. To accomplish this, nodes need to maintain routing information about adjacent (one-hop) nodes. The protocol performs three basic functions of Route creation, Route maintenance, and Route erasure. The first three elements collectively represent the reference level. A new reference level is defined each time a node loses its last downstream link due to a link failure. TORA's route erasure phase essentially involves flooding a broadcast clear packet (CLR) throughout the network to erase invalid routes.

V. Simulation Parameters

Parameter values for Estimated Simulation

Maximum Simulation time	-	100 Seconds
Physical terrain Terrain-Dimensions	-	800 X 800
Number of nodes	-	25
Mobility	-	Mobility Random way Point
Routing Protocol	-	AODV, DSDV, TORA
MAC layer Protocol	-	IEEE 802.11
Node Placement	-	Uniform
Simulation Time	-	10,20,30,40,50,100

5.1 Performance Metrics

While comparing three protocols, we focused on four performance measurements such as Average Delay, Packet Delivery Fraction, and Routing load and network size.

(i) Packet delivery fraction: The ratio of the number of data packets successfully delivered to the destinations to those generated by CBR sources. Packet delivery fraction = (Received packets/Sent packets)*100

(ii) Average End to end delay of data packets: The average time from the beginning of a packet transmission at a source node until packet delivery to a destination. This includes delays caused by buffering of data packets during route discovery, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times. Calculate the send(S) time (t) and receive (R) time (T) and average it.

(iii) Normalized Routing Load: The number of routing packets transmitted per data packet delivered at the destination. Each hop wise transmission of a routing packet is counted as one transmission. Routing Load = Routing Packets Sent / Received Packets

(iv)Number of Nodes and Simulation Time: The models were generated for 10 nodes and 25 nodes with simulation times of 10, 20,30,40,50 and 100.

VI. Varying number of nodes for estimated simulation time

The first set of experiments uses differing the number of nodes and changing the simulations. For the 10 nodes and 20 nodes experiments, we ran the simulator for 10, 20,30,40,50 and 100 Seconds.

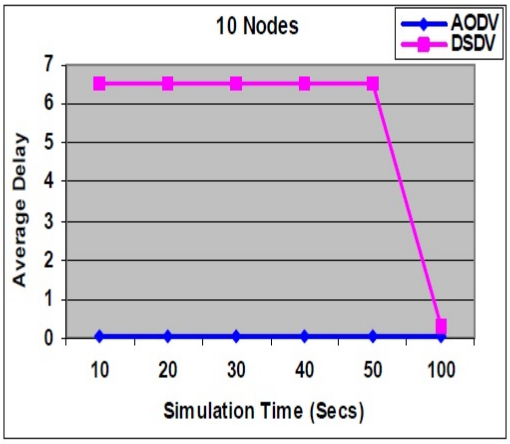

Figure 1: Average delay for the 10-node model with varying estimated Simulation Time

In less stressful situation the AODV has a better Average Delay than DSDV. With 100 Seconds Simulation time the differential is much smaller for both DSDV, AODV. AODV has lowest delay on the data packets received. The reason for this is that it finds routes faster or that the routes are shorter or more optimal. AODV with only MAC-layer support makes the protocol completely on demand.

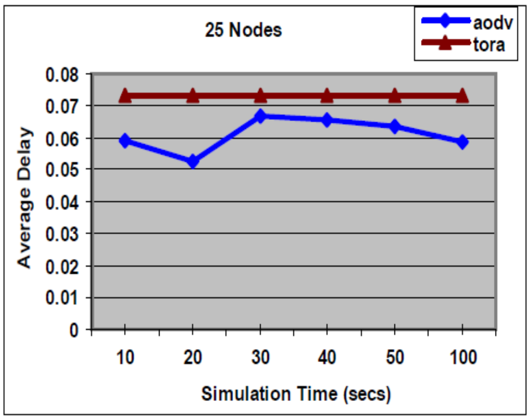

Figure 2: Average delay for the 25-node model with varying estimated Simulation Time

In stressful situation, the Average Delay of AODV protocol with Simulation time of 10, 20, 30, 40, 50 and 100 are smaller than the TORA. TORA shows a steady Average Delay for varying Simulation Time. One interesting observation is that the Average Delay increases, if the simulation times are 30, 40 and 50 of AODV. This is due to a high level of network congestion and multiple access interferences at certain region of the ad hoc network.

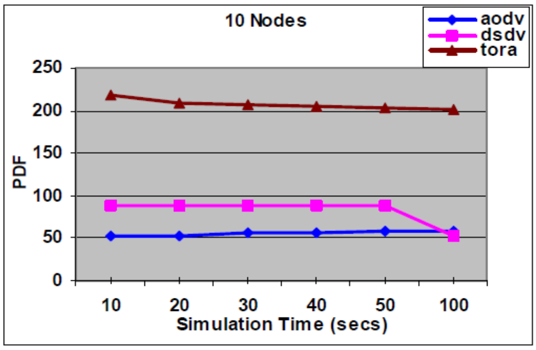

Figure 3: Packet Delivery Fraction for 10-node model with increased estimated Simulation Time

As far as PDF is concerned in 10 nodes AODV performs better than the two protocols namely DSDV and TORA. When the Simulation time is increased from 50 to 100, the PDF of DSDV protocol is smaller than AODV.DSDV does poorly, dropping to a 50% of Packet Delivery Ratio at the simulation time of 100 seconds, nearly 50% of the dropped packets are lost because a stale routing table entry directed them to be forwarded over a broken line.

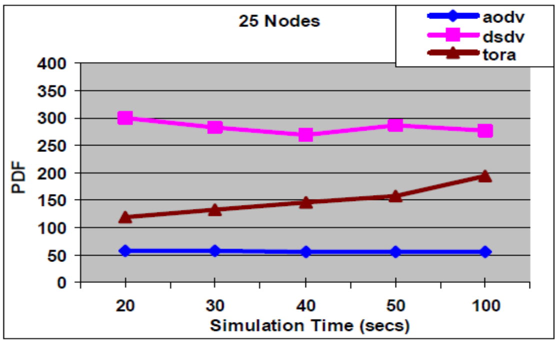

Figure 4: Packet Delivery Fraction for 25-node model with increased estimated Simulation Time

In stressful situation, the simulations were carried out for 25 nodes. In this situation AODV has had better Packet Delivery Fraction than TORA. If the simulation time increases the TORA outperforms in 50 and 100 Simulation time. The reason is the aggressive use of route caching.

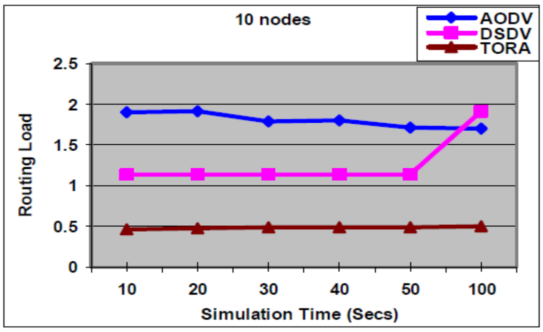

Figure 5: Routing Load for 10-node model with increased estimated Simulation Time

Less stressful situation TORA has lower routing load than DSDV and AODV. If we increase the Simulation time from 50 Seconds to 100 Seconds the Routing Load is high in DSDV. This is expected due to the more rapid change in the topology of the network. But there were no change in TORA and AODV.

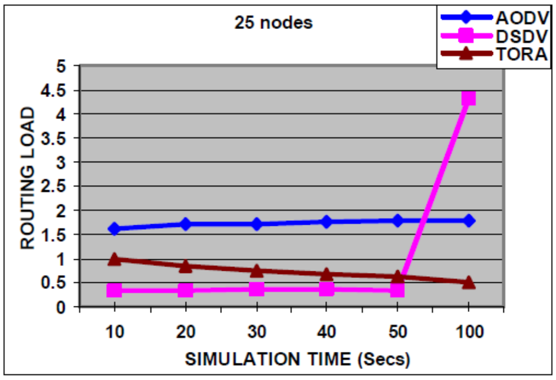

Figure 6: Routing Load for 25-node model with increased estimated Simulation Time

In stressful situation the simulation carried out DSDV demonstrates lower routing load than TORA and AODV, if we increase the simulation time from 50 Seconds to 100 Seconds the routing load is high in DSDV in both the cases. The number of packets received is 50% of the packet sent. So the routing load is increasing at the simulation time of 50 Seconds onwards. This is due to table driven approach of DSDV maintaining information.

VII. Conclusion

In this paper, we proposed a holistic approach to minimize the total energy consumed by both mobility of relays and wireless transmissions. Most previous work ignored the energy consumed by moving mobile relays. When we model both sources of energy consumption, the optimal position of a node that receives data from one or multiple neighbours and transmits it to a single parent is not the midpoint of its neighbours; instead, it converges to this position as the amount of data transmitted goes to infinity. Ideally, we start with the optimal initial routing tree in a static environment where no nodes can move. Our approach improves the initial configuration using two iterative schemes. The first inserts new nodes into the tree. The second computes the optimal positions of relay nodes in the tree given a fixed topology. This algorithm is appropriate for a variety of data-intensive wireless sensor networks. It allows some nodes to move while others do not because any local improvement for a given mobile relay is a global improvement and the three MANET routing protocols were evaluated with varying MANET Size and Simulation times for mobile ad hoc networks using estimated NS-2 simulation. The general observation from the simulations is the application oriented performance metrics such as Average delay; Packet Delivery Fraction, Routing Load and varying number of nodes and Simulation times were analyzed. AODV exhibits a better behaviour in terms of the Average Delay. This better performance is explained by a soft-state updating mechanism employed in AODV to determine the freshness of the routes. In less stressful situation, the Packet Delivery Fraction, the TORA outperforms DSDV and AODV. In stressful situation DSDV outperforms AODV and TORA.

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