Optimization Of Anycast Packet Forwarding Approach For WSN

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ABSTRACT

This paper describes the topic based on minimizing the delay and maximizing the lifetime of event-driven wireless sensor networks, for which events occur in frequently. In such systems, most of the energy is consumed when the radios are on, waiting for an arrival to occur. Sleep-wake scheduling is an effective mechanism to prolong the lifetime of these energy-constrained wireless sensor networks. However, sleep-wake scheduling could result in substantial delays because a transmitting node needs to wait for its next-hop relay node to wake up. An interesting line of work attempts to reduce these delays by developing any cast.-based packet forwarding schemes, where each node opportunistically forward]s a packet to the neighboring node that wakes up among multiple candidate nodes. Wireless sensor network (WSNs) consists of many sensor nodes and these networks are deployed in different classes of applications for accurate monitoring. Wireless sensor nodes are limited energy supply has constrained the lifetime of a sensor network. Nodes in wireless sensor network are densely located and there is duplication of sensed data. This happens because of multiple nodes sensing same event. Such data duplication is responsible for wastage of node energy. Since energy conservation is one of the key issue in WSNs. So, data fusion and data aggregation should be used in order to save energy. Data aggregation is effective method to eliminate redundancy and to minimize the number of transmission. In this paper we present an efficient data aggregation strategy based on tree & cluster formation which eliminates such data duplication and improves node energy efficiency provides the best aggregation quality when compared to other existing systems.

KEYWORDS-COMPONENT:- Anycast, Sleep-wake scheduling, Sensor network, Energy-efficiency, Delay

1.INTRODUCTION

Wireless sensor networks (WSNs) have a significant potential in applications interacting with the physical world, such as surveillance and environmental monitoring. In many of these applications, the use of battery-powered sensor nodes greatly eases the deployment of the network, but the limited capacity of these batteries substantially limits the network lifetime. One of the largest sources of energy consumption in wireless nodes is the use of *idle listening*, and many solutions to reducing this problem in WSNs have been proposed based on the use of *duty cycling* . In duty cycling, sensor nodes periodically alternate between being active and sleeping. When active, a node is able to transmit or receive data, whereas when sleeping, the node completely turns off its radio to save energy; duty cycles of 1–10% (percentage of time in the active state) are typical in order to maximize energy savings. In order to transmit a packet from one node to another, the radios of both nodes must be on, motivating the use of synchronization between the operational cycles of different nodes. Examples of protocols using synchronized approaches include S-MAC, T-MAC, and RMAC. Duty cycling is a widely used mechanism in wireless sensor networks (WSNs) to reduce energy consumption due to idle listening, but this mechanism also introduces additional latency in packet delivery. Several schemes have been proposed to mitigate this latency, but they are mainly optimized for light traffic loads. A WSN, however, could often experience busty and high traffic loads, such as due to broadcast or converge cast traffic. A new MAC protocol, called Demand Wakeup MAC (DW-MAC),that introduces a new low-overhead scheduling algorithm that allows nodes to wake up on demand during the Sleep period of an operational cycle and ensures that data transmissions do not collide at their intended receivers. This demand wakeup adaptively increases effective channel capacity during an operational cycle as traffic load increases, allowing DW-MAC to achieve low delivery latency under a wide range of traffic loads including both unicast and broadcast traffic. Decreasing the hold on and improving the life-time of event-driven wsn signal methods, for which actions occur irregularly. The awaken organizing is a useful process to proceed the life-time of these energy-constrained wsn signal methods but due to this the shifting node needs to hold on for its next-hop connect node to activate. To decrease these difficulties there is a need to make any cast-based package delivering methods, where each node capably forward a packet to the first close by node that activates among several candidate nodes. In this program, we first research how to enhance the delivering methods for lowering the expected packet-delivery difficulties from the signal nodes to the strain. Depending on the result, we then provide a solution to the mixed control problem of how to successfully control the program aspects of the sleep-wake organizing technique and the any throw packet-forwarding technique to improve the program life-time, subject to a limitation on the expected end-to-end packet-delivery hold on or wait. Our computation indicates that the recommended solution can outperform prior heuristic solutions in the fictional works, especially under the genuine conditions where there are challenges, e.g., a lake or a mountain, in the security area of wsn signal methods.

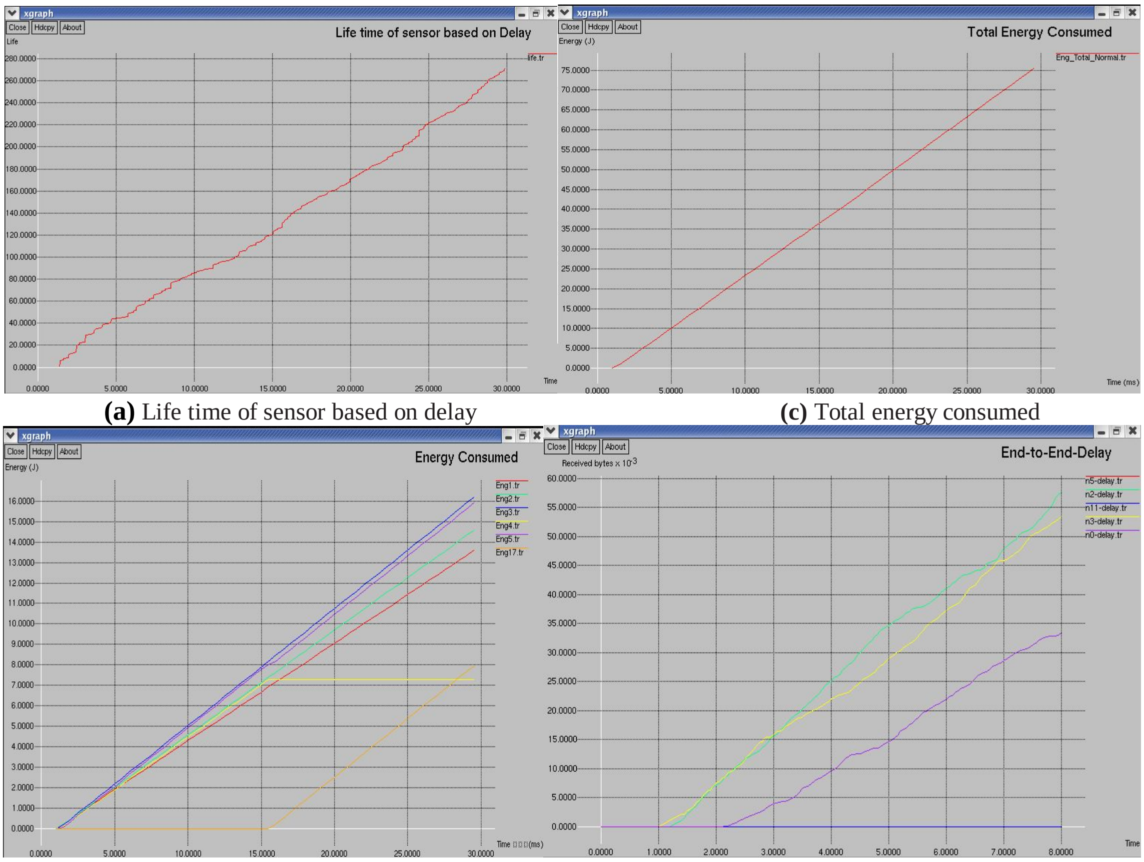
METHODOLOGY

- To understand the concept of wireless sensor networking.
- To understand the anycast packet forwarding technique.
- Literature survey related to various wireless sensor techniques.
- Place the nodes randomly to form a network.
- Obtain the position of each node in the network.
- Calculate the transmission cost by sending data from node to node.
- Compare the various costs with previous technologies

2.RESULTS

2.1SIMULATION EVALUATION

We evaluated DW-MAC using version 2.29 of the *ns-2* simulator, under both unicast and broadcast traffic. Under unicast traffic, we compared DW-MAC against S-MAC, S-MAC with adaptive listen- ing, and RMAC. Under broadcast traffic, because broadcast is not supported in S-MAC with adaptive listening or in RMAC, we com- pared DW-MAC only against S-MAC, in which a broadcast packet is transmitted during a Data period without using RTS/CTS [27]. Table 1 summarizes the key networking parameters used in our simulations. In our simulations, each sensor node has a single omni-directional antenna, and we use the common *ns-2* combined free space and two-ray ground reflection radio propagation model. Except for the parameters on radio power consumption above, which are typical values for Mica2 radios (CC1000) [28], we used the default settings in the standard S-MAC simulation module dis- tributed with the *ns-2.29* package, also used for evaluations of S- MAC and RMAC in previous work [5]. The transition time of the CC1000 radio between sleep and active states is around 2.47 ms [3], but the state transition power is not available in the data sheet. Although the state transition power is normally much lower than Tx or Rx power, in order not to favor DW-MAC, which re- quires more state transitions than S-MAC in this aspect, we set the state transition power to the same value of Tx power. We observed similar trends in our results even if the state transition power is 0. In evaluating power efficiency, we focus on energy consumed by ra- dios but ignore energy consumed by other components such as CPU and memory [23]. The transmission range and the carrier sensing range are modeled after the 914MHz Lucent WaveLAN DSSS ra- dio interface, which is not typical for a sensor node, but we use these parameters to make our results comparable to those reported in previous work, and since measurements have shown that similar proportions of the carrier sensing range to the transmission range are also observed in some state-of-art sensor nodes [1]. In our simulations, we keep the same duty cycle of 5% for S- MAC, RMAC, and DW-MAC. The durations for the Sync, Data, and Sleep periods we used are shown in Table 2. For DW-MAC, we use the same duty cycle-related parameters that were used in the evaluation of RMAC in [5] for generating comparable results. The data packet size used in our simulations was 100 bytes, although a maximum packet size of 256 bytes is supported by the CC1000 radios [13] and by the parameters used in our simulations. To simplify our evaluations, we do not include routing traffic in the simulations and assume that there is a routing protocol de- ployed to provide the shortest path between any two nodes. We also ensure that every network we used in our simulations is a con- nected network. In addition, we do not include any synchronization traffic and assume all the nodes in the network have already been synchronized to use a single wake-up and sleep schedule. For simulations under unicast traffic, each run contains unicast packets toward a sink node that are triggered by a series of 500 events, and each average value is calculated from the results of 10 random runs. For simulations under broadcast traffic, each run con- tains 500 broadcast packets generated by a sink node, and each av- erage value is calculated from the results of 30 random runs. Con- fidence intervals of the average values are not shown because even 99% confidence intervals are so close to average values that they overlap with the data point markers.



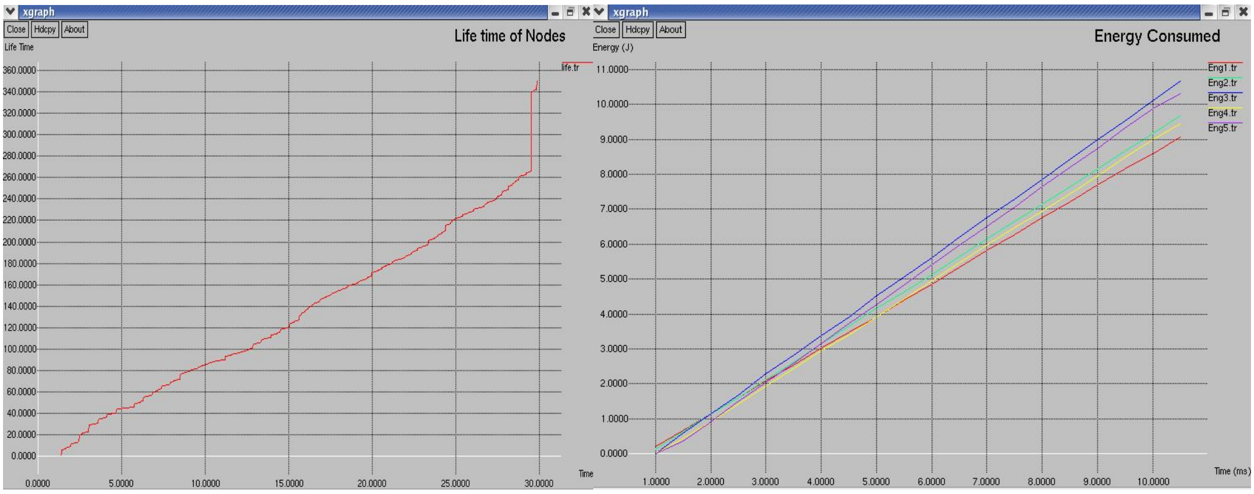
(a) Life time of sensor based on delay **(c)** Total energy consumed

(c) Energy consumed **(d)** End-to-end delay

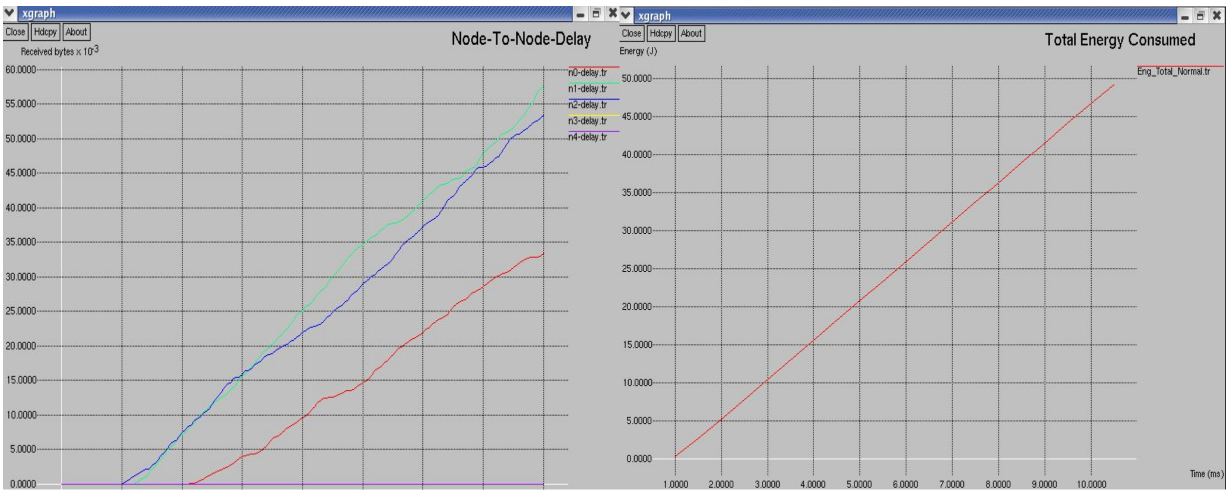
Figure1: Performance for unicast traffic in 49-node (7×7) grid network scenarios.

3.EVALUATION UNDER UNICAST TRAFfiC

We compare DW-MAC with S-MAC, S-MAC with adaptive lis- tening (shown as S-MAC-AL in all figures), and RMAC both in a 49-node (7×7) grid network and in random networks. In the grid network, each node is 200 meters from its neighbours, and the sink node is at the center. Based on a correlated-event workload [10], we introduce a Random Correlated-Event (RCE) traffic model to simulate the impulse traffic triggered by spatially-correlated events commonly observed in detection and tracking ap- plications. RCE picks a random (x, y) location for each event. If every node has a sensing range R, only nodes that are within the circle centered at (x, y) with radius R generate packets to report this event. We adjust the sensing rage R to simulate different degrees of workload in a network. In our experiments, a new event is gen- erated once every 200 seconds, and each node having sensed the event sends one packet to the sink node. We vary R from 100 me- ters to 500 meters; the average number of packets generated per event is listed in Table 3. Note that an event triggers at most one packet when R is 100 meters. The lengths of paths traversed by these packets range from 1 to 6 hops, and the average is 3.05. In this way, we explore how efficiently S-MAC, S-MAC with adaptive listening, RMAC, and DW-MAC handle different degrees of traffic load. The performance of these protocols for unicast traffic in the 49-node grid network scenarios is shown in Figure 8. Figure 8(a) shows the average and maximum end-to-end latency of packets in the RCE model as the sensing range (and thus traffic load) increases. DW-MAC has a much smaller rate of increase than do S-MAC and RMAC. When there are around 15 packets generated for each event with the 500-meter sensing range, DW-MAC reduces average end-to-end delay by around 70% compared to S- MAC and RMAC. DW-MAC outperforms S-MAC because DW- MAC allows more transmissions in a cycle by using the Sleep pe- riod for actual data transmissions. RMAC experiences more delay than DW-MAC as workload increases, because of increased packet collisions caused by scheduling conflicts. It is the retransmission effort to recover these collided packets that results in larger end-to- end delay. When the sensing range is 500 meters, the maximum end-to-end delay with RMAC is 374.95 seconds, which is off the top of the graph. This extreme delay occurs when a packet gen- erated for one event failed to reach the sink before the next event happened. Under the light traffic with the 100-meter sensing range, DW-MAC shows slightly larger delay than RMAC, due to the time that a received data packet is forwarded to the next hop in multihop forwarding. In RMAC, a data packet is forwarded immediately, whereas in DW-MAC, forwarding starts at a later time determined by the corresponding SCH frame. This extra delay experienced by DW-MAC, however, is less than the duration of a Sleep period. S- MAC with adaptive listening shows slightly larger delay compared to DW-MAC. This low delay achieved by adaptive listening, how- ever, comes at the cost of lower packet delivery ratio and increased energy consumption as shown next. The packet delivery ratios corresponding to Figure 8(a) are shown in Figure 8(b). DW-MAC maintains close to 100% packet delivery ratio and outperforms the other protocols across all sens- ing ranges. The delivery ratio with S-MAC with adaptive listening drops quickly, since with larger the sensing ranges, more collisions are caused by transmissions from hidden nodes, as we discussed in Section 2; in addition, a node may transmit a packet when its in- tended receiver is in sleep state, further decreasing packet delivery ratio. DW-MAC and RMAC outperform S-MAC mainly for two reasons. First, they only transmit short scheduling frames during a Data period, avoiding collisions between a control frame and a long data frame. Second, a node does more retransmission attempts for a data packet in DW-MAC and RMAC. Specifically, a sched- uling frame sent by both as RTS and as CTS; even if this frame fails to reach the next-hop neighbor, the intermediate node does not increase its retry count, as the node has not received the corresponding data packet yet, although the node has attempted to reserve the medium to forward the incoming data packet once. Even with such extra retransmission attempts, the delivery ratio of RMAC drops more quickly than that of DW-MAC beyond a 400-meter sensing range, as retransmissions are not enough to recover the increased colli- sions due to RMAC's scheduling conflicts.



(a). New life time of nodes **(c).** New Energy consumed



(b). New Total Energy Consumed **(d).** New node-to-node delay

Figure2: Performance for random correlated-event traffic in 50-node networks with sensing range of 250 m.

Figure 8(c) shows the average energy consumption of nodes versus sensing ranges in the 49-node grid network scenarios. Under light workload, when the sensing range is 100 meters, all four MAC protocols show almost the same power consumption, but when traf- fic load increases as the sensing range gets larger, average energy consumption in all protocols except DW-MAC increases quickly (energy consumption for DW-MAC does increase, but increases very slowly). When the sensing range is 500 meters, DW-MAC consumes less than 50% of the energy consumed by S-MAC with adaptive listening to achieve even lower packet delivery latency. We also compare S-MAC, S-MAC with adaptive listening, RMAC, and DW-MAC in 100 random networks, each with 50 nodes randomly located in a 1000 m × 1000 m area. For each network, one random node is chosen as the sink, and the RCE model with 250-meter sensing range is used to generate 500 events, once every 200 seconds. We conduct one simulation run for each net- work, and 3845 packets are generated in each run on average. The results are plotted in Figure 9. For the same reasons discusses above, DW-MAC outperforms the other three protocols in delivery latency, delivery ratio, and energy consumption. Figure 9(a) show the CDF of end-to-end latency for all packets in all 100 runs. Aver- age end-to-end latency with S-MAC, S-MAC with adaptive listen- ing, RMAC, and DW-MAC are 61.8%, 21.6%, 36.7%, and 15.7%, respectively. Although adaptive listening greatly reduces end-to- end latency for S-MAC, this gain is at the cost of lower delivery ratio and more energy consumption. Figure 9(b) shows the CDF of delivery ratios in these 100 runs. The average delivery ratios of S-MAC, S-MAC with adaptive listening, RMAC, and DW-MAC are 99.63%, 95.03%, 99.99%, and 99.99%, respectively. The aver- age energy consumptions of the sensors are plotted in Figure 9(c), where the average values with S-MAC, S-MAC with adaptive lis- tening, RMAC, and DW-MAC are 1.386, 2.666, 1.724, and 1.163 mW, respectively. The trends observed in these random networks are consistent with those observed in the 49-node grid network.

4.EVALUATION UNDER BROADCAST TRAFfiC

We compared DW-MAC with S-MAC, both in regular grid net- works and in random networks, under broadcast traffic In the grid network, the sink node is at the center, and each node is 200 meters from its neighbors. We vary the grid size from 3 × 3 (9 nodes) to 11 × 11 (121 nodes). The sink node generates a broadcast packet once every 100 seconds so that transmissions for one packet complete before the next packet is generated. Due to space limits, we evaluate DW-MAC under only two categories of broadcast protocols: simple flooding (all nodes that have re- ceived a broadcast packet rebroadcast it exactly once, indicated by “ALL”) and Connected Dominating Set (CDS) based flooding (only nodes in a CDS that have received a broadcast packet rebroadcast it exactly once, indicated by “CDS”). The CDS is formed by the algorithm by Gandhi et al. [8], with a slight modification to al- ways include the sink node in the CDS; the results for our opti- mized multihop forwarding for broadcast traffic are indicated by “DW-MAC CDS-MH.” Note that this CDS algorithm is designed to minimize broadcast latency, and the resulting CDS is not neces- sarily an minimum CDS.

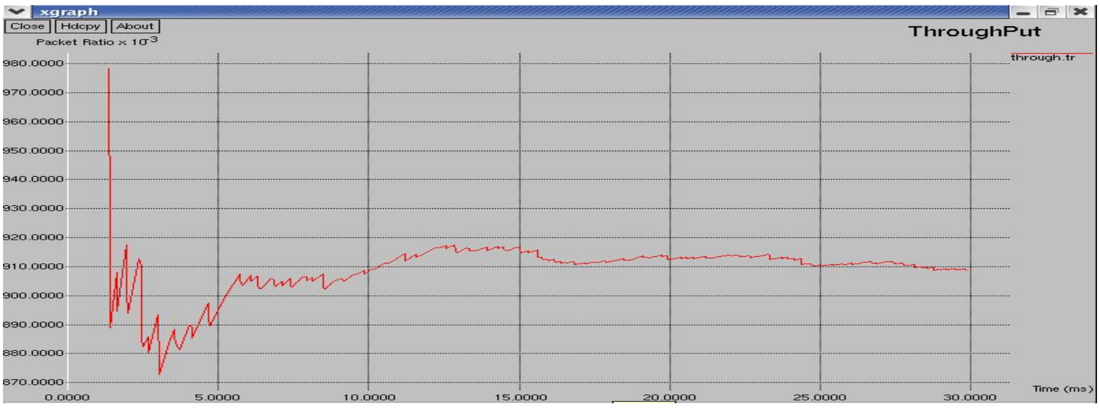


Figure 3: ThroughPut graph for anycast broadcasting

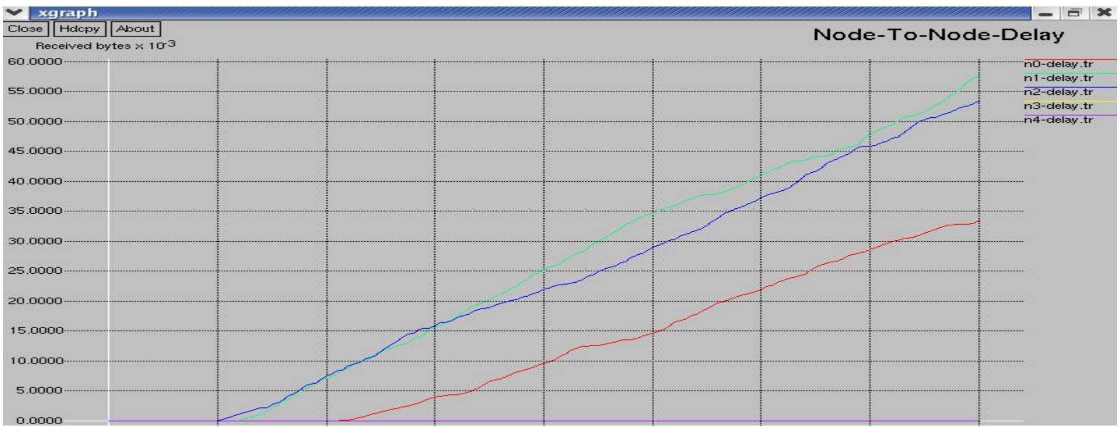


Figure 4: Node-to node delay graph for new thesis of anycast network

The interval between traffic bursts is changed from 200 seconds to 100 seconds to show the differences among protocols more clearly. DW-MAC reduces average energy consumption over S-MAC by about 26% under simple flooding and by about 18% under CDS- based flooding. DW-MAC achieves these savings by not overhear- ing data transmissions. In DW-MAC, a node only attempts to re- ceive an incoming packet after receiving an SCH that indicates the packet has not been received. Simple flooding consumes more en- ergy because of more rebroadcasts. Whether or not the optimized multihop forwarding is used, a flooding results in the same num- ber of transmissions, so this optimization does not affect energy consumption much. Finally, we compare these broadcast protocols in 100 random networks, the same networks used for evaluations under unicast traffic. The sink in each network generates 500 broadcast packets in each run, one packet every 100 seconds. Figure 11(a) shows the CDF of end-to-end latency for all packets in the 100 runs. All DW- MAC based broadcast protocols show much smaller end-to-end la- tency than those based on S-MAC. The average end-to-end latency for S-MAC ALL, S-MAC CDS, DW-MAC ALL, DW-MAC CDS and DW-MAC CDS-MH are 49.1, 34.8, 24.2, 20.8, and 16.0 sec- onds, respectively. On average, end-to-end latency is reduced by more than 50% both in simple flooding and in CDS-based flood- ing. Unlike the results in grid networks, DW-MAC shows lower average end-to-end latency in CDS-based flooding than those in simple flooding, because the speedup gained by fast propagation along CDS nodes is often greater than the slowdown caused by defers in these networks. For these 100 runs, the CDF of deliv- ery ratios is shown in Figure 11(b), and the CDF of average en- ergy consumption is shown in Figure 11(c). S-MAC ALL, S-MAC CDS, DW-MAC ALL, DW-MAC CDS, and DW-MAC CDS-MH, respectively, show average delivery ratios of 98.6%, 92.1%, 99.0%, 95.0% and 96.4% and average energy consumption of 1.785, 1.355, 1.288, 1,185, and 1.183 mW. The difference in energy consumption between DW-MAC CDS and DW-MAC CDS-MH is almost invisi- ble because the optimized multihop forwarding does not affect the number of data transmissions much. Overall, DW-MAC achieves lower end-to-end delays, higher delivery ratios, and more energy savings for broadcast traffic in these random networks.

5.DISCUSSION/ANALYSIS

Joohwan Kim, Xiaojun Lin, Ness B, Shroff, Prasun Sinha, IEEE-2010 , in this paper ”Minimizing Delay and Maximizing Lifetime for Wireless Sensor Networks With Anycast”,explained that lifetime of nodes in wireless sensor networks can be increased by using sleep wake scheduling algorithm and event reporting delay can be reduced by using selective traditional anycast packet forwarding technique.

Yanjun Sun, Shu Du, Omer Gurewitz, David B. Johnson (MobiHoc-2008) , in this paper "DW-MAC:A Low Latency, Energy Efficient Demand- Wakeup MAC Protocols for Wireless Sensor Networks", explained that Duty cycling is a widely used mechanism in wireless sensor networks (WSNs) to reduce energy consumption due to idle listening, but this mechanism also introduces additional latency in packet delivery. Several schemes have been proposed to mitigate this latency, but they are mainly optimized for light traffic loads. A WSN, however, could often experience bursty and high traffic loads, such as due to broadcast or convergecast traffic. In this paper, they present a new MAC protocol, called Demand Wakeup MAC (DW-MAC), that introduces a new low-overhead scheduling algorithm that allows nodes to wake up on demand during the Sleep period of an operational cycle and ensures that data transmissions do not collide at their intended receivers. This demand wakeup adaptively increases effective channel capacity during an operational cycle as traffic load increases, allowing DW-MAC to achieve low delivery latency under a wide range of traffic loads including both unicast and broadcast traffic. They compare DW-MAC with S-MAC (with and without adaptive listening) and with RMAC using ns-2 and show that DW-MAC outperforms these protocols, with increasing benefits as traffic load increases. For example, under high unicast traffic load, DW-MAC reduces delivery latency by 70% compared to S-MAC and RMAC, and uses only 50% of the energy consumed with S-MAC with adaptive listening. Under broadcast traffic, DWMAC reduces latency by more than 50% on average while maintaining higher energy efficiency.

Sha Liu, Kai-Wei Fan and Prasun Sinha,The Ohio State University(2007) in this paper “CMAC: An Energy Efficient MAC Layer Protocol Using convergent Packet Forwarding for Wireless Sensor Networks” explained that low duty cycle operation is critical to conserve energy in wireless sensor networks. Traditional wake-up scheduling approaches either require periodic synchronization messages or incur high packet delivery latency due to the lack of any synchronization. In this paper, they present the design of a new low duty-cycle MAC layer protocol called Convergent MAC (CMAC). CMAC avoids synchronization overhead while supporting low latency. By using zero communication when there is no traffic, CMAC allows operation at very low duty cycles. When carrying traffic, CMAC first uses any cast to wake up forwarding nodes, and then converges from route-suboptimal any cast with unsynchronized duty cycling to route-optimal unicast with synchronized scheduling. To validate design and provide a usable module for the community, they implement CMAC in TinyOS and evaluate it on the Kansei testbed consisting of 105 XSM nodes. The results show that CMAC at 1% duty cycle significantly outperforms BMAC at 1% in terms of latency, throughput and energy efficiency. They also compare CMAC with other protocols using simulations. The results show for 1% duty cycle, CMAC exhibits similar throughput and latency as CSMA/CA using much less energy, and outperforms SMAC and GeRaF in all aspects.

David Culler, Jonathan Hui, Philip Levis, Scott Shenker, Ion Stoica, and Jerry Zhao Joseph Polastre (October 20, 2005) in this paper "A unifying link abstraction for wireless sensor networks" explained technological advances and the continuing quest for greater efficiency have led to an explosion of link and network protocols for wireless sensor networks. These protocols embody very different assumptions about network stack composition and, as such, have limited interoperability. It has been suggested that, in principle, wireless sensor networks would benefit from a unifying abstraction (or "narrow waist" in architectural terms), and that this abstraction should be closer to the link level than the network level. This paper takes that vague principle and turns it into practice, by proposing a specific unifying sensornet protocol (SP) that provides shared neighbor management and a message pool.The two goals of a unifying abstraction are generality and efficiency: it should be capable of running over a broad range of link-layer technologies and supporting a wide variety of network protocols, and doing so should not lead to a significant loss of efficiency. To investigate the extent to which SP meets these goals, we implemented SP (in TinyOS) on top of two very different radio technologies: B-MAC on mica2 and IEEE 802.15.4 on Telos. They also built a variety of network protocols on SP, including examples of collection routing , dissemination and aggregation . Measurements show that these protocols do not sacrifice performance through the use of our SP abstract.

ROY ET AL, "ROUTING WITH ANYCASTING IN AD-HOC NETWORKS (2004)"

Wireless ad hoc networks are infrastructureless multi-hop networks in which nodes behave as mobile routers. The intermediate node is often faced with the decision to choose between two of its neighbors, both of which may be equally good for forwarding the packet to the final destination. Selection is then made randomly, without respecting the possibility that one of the nodes may not be suitable for immediate transmission. Anycasting paradigm can be quite useful in such scenario. Roy et al. (2004) propose MAC layer anycasting and claim that it can make educated decisions in such scenarios, leading to potential benefits in performance. However they argue that MAC-layer anycasting can introduce several tradeoffs and can be disadvantageous in certain aspects. To avoid these tradeoffs we propose to enhance MAC layer anycasting with the use of metric based filters in anycasting. Their work is greatly influenced by the research of Zegura et al. (2000). They believe this technique can enhance the performance (with added advantage of some sort Of QoS to be delivered) without much overheads as involved in MAC layer anycasting.

6.CONCLUSIONS

- However, in synchronized sleep wake scheduling such synchronization procedure could incur additional communication overhead, and consume a considerable amount of energy.
- However, this on demand sleep-wake scheduling can significantly increase the cost of sensor motes due to the additional receivers.
- However, in asynchronized sleep wake scheduling, because it is not practical for each node to have complete knowledge of the sleep-wake schedule of other nodes, it incurs additional delays along the path to the sink because each node needs to wait for its next-hop node to wake up before it can transmit. This delay could be unacceptable for delay-sensitive applications, such as fire detection or tsunami alarm, which require that the event reporting delay be small.
- Under traditional packet-forwarding schemes, every node has one designated next-hop relaying node in the neighborhood, and it has to wait for the next-hop node to wake up when it needs to forward a packet. Each node has multiple next-hop relaying nodes in a candidate set (we call this set a forwarding set). A sending node can forward the packet to the first node that wakes up in the forwarding set. Anycast forwarding reduces the event-reporting delay and minimizes the power consumption by using optimum methods.
- The route distance between nodes of wireless sensor network will be optimum.
- The power consumption between location points and sensors will be least optimum.
- The Bandwidth utilization will be maximum.
- The event reporting delay will be small.

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