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Enhanced Network Lifetime Improvement by Effort and Anycast in Wsn

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Abstract: *Designing a lifetime-maximization routing in wireless sensor networks poses a great challenge mainly due to unreliable wireless links and limited power supply.The lifetime maximization can be achieved by EFFORT which is an opportunistic routing where the path diversity and the improvement of transmission reliability is improved. Besides, asynchronous sleep-wake scheduling is an effective mechanism named ANYCAST to reduce energy consumption by appropriately arranging sensor nodes to sleep. In this Paper we exploit two methods called EFFORT and ANYCAST to maximize the network lifetime in WSN.Simulation results show that both methods effectively achieves network lifetime extension compared with other routing schemes.*

I. Introduction

The advent of research topics in Wireless Sensor Networks (WSNs) over the past few years comes from the diversity of their applications and the challenges of deployment issues. Wireless sensors, which combine the capability of sensing and wireless communication, are suitable for lots of applications such as military surveillance, temperature monitoring, wildlife tracking, and disaster warning system. Due to unreliable wireless links and limited power supply, the routing must be carefully designed to conserve energy for extending the network lifetime, which is defined as the time until the first node depletes its energy .

Due to channel fading and wireless contention, data transmission over wireless links is prone to failure. By involving multiple forwarders, opportunistic routing not only reduces the number of retransmissions, but also introduces randomness for perhop forwarders adaptation. Though opportunistic routing provides two desirable natural advantages, we observe that the performance of an OR scheme significantly depends on the design of the metric applied in forwarder selection as well as prioritization. In Fig.1 red circles indicates the source and destination node. In example every node broadcast the message to the neighboring nodes & this process continues in operation when desired destination is encountered some node emerge gateways to the subsection of the network.

Another aspect for energy conservation is sleep-wake scheduling, which appropriately arrange sensor nodes to sleep when data transmission/reception is not needed.

In a sleep mode, the communication module of a sensor node is turned off; thus, the energy consumption is fairly low. Moreover, to avoid the energy consumption of clock synchronization, asynchronous sleep-wake scheduling makes sensor nodes wake up independently with the given rate. Asynchronous sleep-wake scheduling is suitable for a wireless sensor network, because it is easily implemented and can be done locally without additional communication overhead.

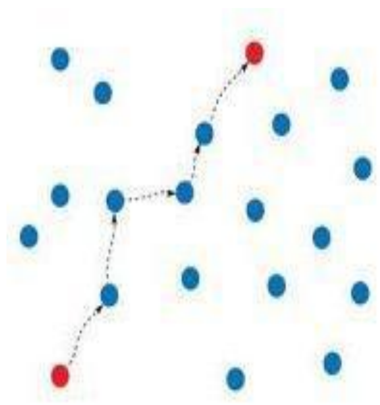

Fig.1. Example of mobile nodes communication

Based on the above discussions, both opportunistic routing and asynchronous sleep-wake scheduling can effectively reduce energy consumption for a wireless sensor network. The goal of this paper is to develop a joint design of synchronous Sleep-wake Scheduling and Opportunistic Routing Technology, called EFFORT and ANYCAST, in order to prolong the network lifetime of a wireless sensor network. More specifically, this method allows sensor nodes to switch into sleep modes for power saving, and to forward data by jointly considering energy capability, link reliability, and sleep-wake schedules.

II. Related Work

2.1 Overview of Opportunistic Routing

In traditional fixed-pathrouting schemes over wireless networks, each node selectsspecific nodes to relay data according to a given metric. However, the designated relay nodes may fail to receive data over unreliable wireless links even if the most reliable link is selected. As a result, the sender must retransmit the packets to the relay nodes. In reality, all neighboring nodes in the transmission range of the sender can overhear the relayed packets because of the broadcast nature of wireless channel. As more than a single node is involved, the number of retransmission can be reduced because the probability that at least one forwarder receives the packets increases.

2.2 Overview of sleep wake scheduling

In 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 forward a packet has to be done. In contrast, under anycast packet-forwarding schemes, each node has multiple next-hop relaying nodes in a candidate set (we call it as forwarding set) and forwards the packet to the first node that wakes up in the forwarding set. Sleep-wake scheduling protocol have been proposed in literature.

In synchronized sleep–wake scheduling protocols sensor nodes periodically or aperiodically exchange synchronization information with neighbouring nodes. However, such synchronization procedures could incur additional communication overhead and consume a considerable energy. On-demand sleep–wake scheduling protocols is one scheduling where nodes turn off most of their circuitry and always turn on a secondary low-powered receiver to listen to “wake-up” calls from neighbouring nodes when to relay the packet. But this on-demand sleep–wake scheduling can significantly increases sensor nodes cost due to the additional receiver.We propose a metric, called OEC, which can reflect the curtailment of network-lifetime caused by each data transmission.

The design of OEC aims at allowing each intermediate sensor to determine its forwarding set and relay sequence for prolonging the network-lifetime. Second, we develop a routing algorithm, EFFORT, which enables each node to compute its optimal OEC value in a distributed manner and addresses the implementation issues of realizing OR on the proposed OEC metric. According to sleep-wake schedules, each sensor node switches between active and sleep modes.When sensor node u has data to transmit, the sleep-wake schedule is suspended and node immediately wakes up for a period of length called probing period. At the beginning a probing, node broadcasts beacons, i.e., of Fig.2 , to notify nodes in its forwarding set that there exists data needs to be forwarded, and then waits for responses, i.e., of Fig.2. Node can start to do data transmission if it successfully receives an ACK response from any node.

III. Design Of Efffort And Anycast

In this section, we present the proposed OECS metric (Opportunistic Energy Cost with Sleep-wake schedules) and describe the designed routing scheme.

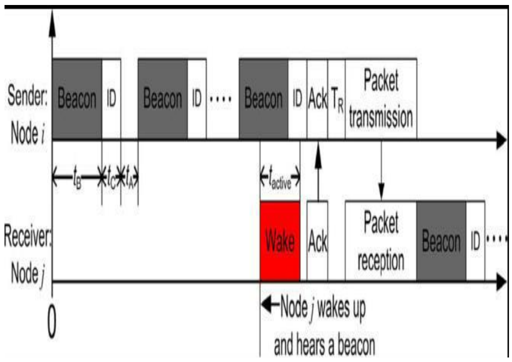

Fig.2 System model

3.3.1.Sleep Wake Scheduling Algorithm

- ✓ Determine the energy consumption for probing periods before sending data, and the energy consumption for wake periods. Energy consumption based on transmission, reception, and idle state per time unit.
- ✓ At beginning a probing, node broadcasts beacons, nodes in its forwarding set that there exists data needs to be forwarded, and then waits for responses.
- ✓ Node can start to do data transmission if it successfully receives an ACK response from any node in its forwarding set.
- ✓ If no other node wakes up for relaying data, node returns to sleep mode and then re-broadcasts beacons until at least one forwarder wakes up.
- ✓ If a sensor node has no data to transmit, it sleeps for random length of intervals that are independent and exponentially distributed with a given average rate of wakeup events.
- ✓ Energy Probability is given by

$$E_{prob} = \mathrm{E}[n_{prob}] \cdot (T_b \cdot e_{tx} + T_s \cdot e_{idle}) + T_s \cdot e_{rx}.$$

- ✓ The forward node will be select based on
- ➢ The energy cost of probing its forwarders,
- ➢ The energy cost in a period from the time when forwarders received probing beacon to the time when forwarders start receiving data,
- ➢ The energy cost of transmitting data from node ,
- ➢ The energy cost of receiving data by all awake forwarders,
- ➢ The expected OECS value of node ’s forwarders to the sinks, and
- ➢ The energy cost of retransmission.
- ➢ Based on this parameter the route will be selected. After selection route the sleep awake scheduling will be applied.

3.3.2 OECS Metric Formulation

Note that the same amount of energy consumption has different degree of impact on sensor nodes with various residual energy. More specifically, a sensor node with less residual energy should more conservatively manipulate its energy. For example, the residual energy of two sensor nodes u and v are 10 units and 2 units, respectively. In contrast with node , consuming one unit of energy is significant for node since its energy is going to be drained out.

Therefore, we define energy cost as the ratio of energy consumption to a sensor node's residual energy for OECS metric; the goal is to minimize energy cost caused by each data transmission. The rationale is to balance energy usage, so the network lifetime can be prolonged.

In order to compute the end-to-end energy cost from a sensor node to the sink, every sensor node has to take the OECS value of all its forwarder into consideration when computing its own OECS value. With this recursive method, every sensor node computes the expected energy cost of data forwarding from a sender to the sink. More specifically, the OECS value of sensor node is the expected opportunistic energy cost from node u to the sink, which is the summation of (1) the energy cost of probing its forwarders, (2) the energy cost in a period from the time when forwarders received probing beacon to the time when forwarders start receiving data, (3) the energy cost of transmitting data from node , (4) the energy cost of receiving data by all awake forwarders, (5) the expected OECS value of node u's forwarders to the sinks, and (6) the energy cost of retransmission.Therefore, the definition of OECS metric for node is represented, where F_u and P_u indicate the forwarding set of node and priority assignment for all nodes of F_u .

Moreover, P_{TS} is the probability that at least one forwarder successfully receives data.

$$OECS(F_u, P_u) = \frac{C_{prob}+C_{wake}+C_{tx}+C_{rx}+C_{fwd\to sink}}{P_{TS}}$$

Each term in equation is described in detail as follows, where r_u is the residual energy of sensor node u .

- ✓ C_{prob} indicates the energy cost of a sender node broadcasting beacon to its forwarders. Hence, C_{prob} is similar to that of E_{prob}
- ✓ C_{wake} denotes the energy cost of the awake forwarders for receiving probing beacon, returning an ACK, and waiting for T_S time unit before they receive data, as shown in Fig2.
- ✓ C_{tx} represents the energy cost of broadcasting data of size toforwarders. Recall that C is the channel capacity for a sensor node.
- ✓ C_{rx} is the energy consumption of receiving data sent from the
- ✓ sender. Only awake forwarders can receive data, so we also

- ✓ consider the probability that a sensor node is awake.
- ✓ $C_{fwd\text{->}sink}$ denotes the expected energy cost of forwarders, which relay the received data after they received data sent from the sender. For those nodes assigned lower priority, they will not relay data unless the nodes, with higher priority in the forwarding set, fail to relay data. In other words, forwarder only has to relay data if forwarder receives the packet correctly and all nodes, having higher priority in the forwarding set, fail to receive data.

3.3.3EFFORT Framework

We now focus on implementation issues of realizing the proposed opportunistic routing protocol (EFFORT) based on the OEC metric, which represents the expected end-to-end SECost

of each data forwarding. We describe three components of EFFORT: (1) procedure of OEC computation, (2) candidate selection and relay prioritization, and (3) data forwarding and OEC updating. The first component enables each sensor to compute its optimal OEC in a distributed manner. The second one lets each sensor locate its optimal forwarding set from its neighbors and determine the relay sequence. The last explains

how the selected forwarders cooperate with each other to relay data and update the OEC value subsequently.

Notation	Description	Notation	Description
T_b	time to send/receive a beacon	T_a	time to send/receive an ACK
$p_{i,j}$	reliability of link $i \to j$	T_s	time to wait for ACK sent from awake receivers
N	total number of sensor nodes	λ	rate of wake-up events with Poisson processes
Δ_{wake}	length of a wake period	H	average hop count from a node to the sink
γ	total data generation rate in a network	$E[n_{prob}]$	expected number of probing period before sending data
δ	size of data per transmission	c	channel capacity of a sensor node
$e_{tx}/e_{rx}/e_{idle}$	the energy consumption for transmission/reception/idle state per time unit		
q	the probability that at least one sensor node in a forwarding set wakes up in Δ_{wake}		
$\tilde{q}$	the probability that a receiver node receives a probing beacon in Δ_{wake}		

Table.1 Notation Table

IV. Simulation Parameter & Discussion

Parameters	Values
Simulator	Ns-2(version 2.32)
Simulation Time	700 (s)
Number of Mobile Nodes	20
Topology Area	800*800 (m)
Packet size	512 Bytes

Table.2 Simulation Parameter

Fig 3 to 5 shows graphical representation of the nodes movement in a network simulator by selecting the simulation parameters required to set up the network.

4.1 Node Deployment

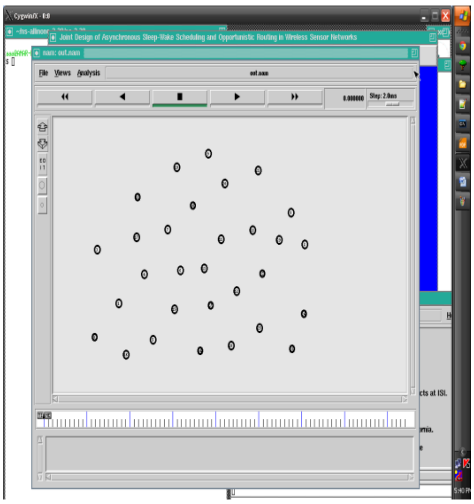

Fig.3 Node Deployment

The nodes of the wireless sensor networks are deployed by using the network simulator NS2.

4.2 Routing

Here the node 2 is considered as source node . The coverage area of source node is also shown.

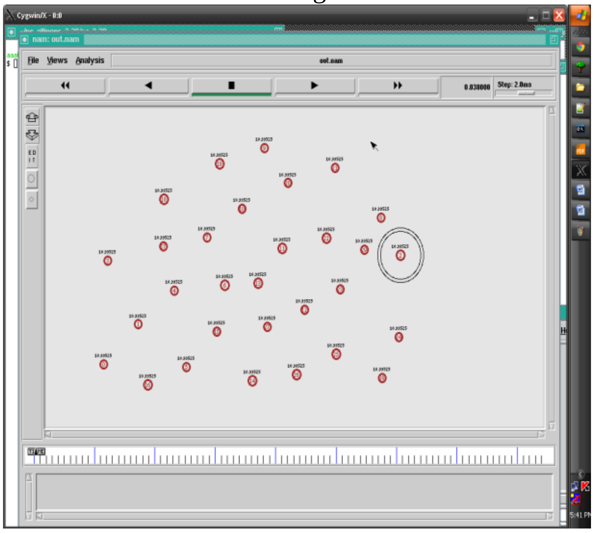

Fig.4 Routing

4.3 Data Transmission

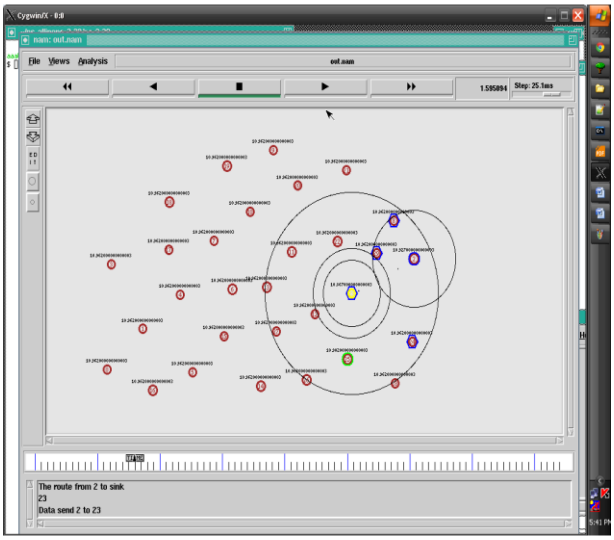

Fig.5 Data Transmission

The neighbour nodes are selected based on the distance .After selecting the neighbour node,whether the node is sleep or awake is to be found.Then the data is transmitted to the awake node. Here the data is transmitted from Source node to sink node. The coverage area of neighbour nodes is also shown.

V. Conclusion And Future Enhancement

In this work, we have proposed ASSORT, which is a joint design of synchronous sleep-wake scheduling and opportunistic routing protocol, to enhance network-lifetime for wireless sensor networks. The operation of ASSORT is based on (a) determining the wake-up rate and the awake period to minimize the additional energy consumption, and (b) an opportunistic metric called OECS which considers the residual energy, link reliability, and sleep-wake schedules. Simulation results show that ASSORT achieves network lifetime.The future enhancement is to select the forward node based on the link quality.

- ✓ LQ = retransmission packet ÷ total no of packets
- ✓ To implement ASSORT on real sensor devices, such as, MicaZ or TelosB

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