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Energy Efficiency in Wireless Sensor Networks Using Packet Splitting Technique

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***Abstract*-The wireless sensor network is an ad – hoc network. It consist of small light weighted wireless nodes called sensor nodes. The analytical model that allows us to derive some accurate results regarding energy consumption and complexity. Also, some main considerations about the implementation of the proposed technique in a real sensor network, i.e., by taking into account erasure channels, MAC-layer overhead, and actual computational resources of nodes. The effect of important parameters such as nodes' density and transmission range through both extensive simulations and an analytical study of the trade-off between energy saving, complexity, and reliability of the proposed technique.**

A novel approach that splits the original messages into several packets such that each node in the network will forward only small sub packets. The splitting procedure is achieved applying the Packet Splitting algorithm and the Chinese remainder theorem algorithm (CRT) which is characterized by a simple modular division between integers. The sink node, once all sub packets is received correctly, will recombine them, thus reconstructing the original message. The splitting procedure is especially helpful for those forwarding nodes that are more solicited than others due to their position inside the network.

Keywords: MAC, CRT.

1. INTRODUCTION

In computer networking there is a great value of wireless networking because it has no difficult installation, no more expenditure and has lots of ways to save money band time. In the field of wireless networking, there is another form of networking which is called as wireless sensor network. A type of wireless networking which is comprised of number of numerous sensors and they are interlinked or connected with each other for performing the same function collectively or cooperatively for the sake of checking and balancing the environmental factors.

The wireless sensor network is an ad - hoc network. It consists of small light weighted wireless nodes called sensor nodes, deployed in physical or environmental condition. All sensor nodes in the wireless sensor network are interacting with each other or by intermediate sensor nodes. A sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable. Every sensor node is equipped with a transducer, microcomputer, transceiver and a power source. The transducer generates electrical signals based on sensed physical effects and phenomena. The microcomputer processes and stores the sensor output. The transceiver, which can be hard-wired or wireless, receives commands from a central computer and transmits data to that computer. The power of each sensor node is derived from the electric utility or from a battery. Total working of wireless sensor networking is based on its construction. The sensor network initially consists of small or large nodes called as sensor nodes. These nodes vary in size and totally depend on the size because different sizes of sensor nodes work efficiently in different fields. Wireless sensor networking has such sensor nodes which are specially designed in such a typical way that they have a microcontroller which controls the monitoring, a radio transceiver for generating radio waves, different type of wireless communicating devices such as batteries.

2. PACKET FORWARDING TECHNIQUE

The packet forwarding Technique is the relaying of packets from one network segment to another by nodes in a computer network. The simplest forwarding model unicasting involves a packet being relayed from link to link along a chain leading from the packet's source to its destination. However, other forwarding strategies are commonly used. Broadcasting requires a packet to be duplicated and copies sent on multiple links with the goal of delivering a copy to every device on the network.

The redundancy adopted is in the form of multiple copies of the same packet that travel to the destination along multiple paths. However, multiple paths could remarkably consume more energy than the single shortest path because several copies of the same packet have to be sent.

2.1 Packet Processing

The Packet Processing refers to the wide variety of algorithms that apply to a packet of data or information as it moves through the various network elements of a communications network. There are two broad classes of packet processing algorithms that align with the standardized network subdivision of control plane and data plane. The algorithms are applied to either, Control information contained in a packet and are used to transfer the packet safely and efficiently from origin to destination The data content (frequently called the payload) of the packet and are used to provide some content-specific transformation or take a content-driven action.

2.2 Packet Splitting

The Packet Splitting was the splitting of the packets into various sub-packets and to split the nodes and transmit packets towards the nodes. The original messages are split into several packets such that each node in the network will forward only small sub packets and reconstruct them back. The splitting procedure is achieved applying the Packet splitting Algorithm. And by this the desired goals have been achieved.

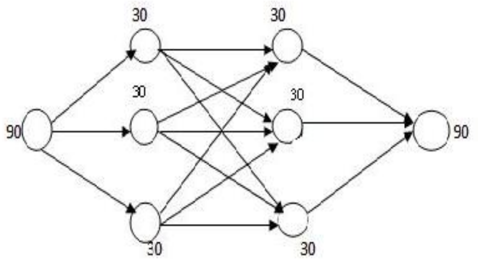

Fig 1 Packet splitting

The sink node, once all sub packets is received correctly, will recombine them, thus reconstructing the original message. The splitting procedure is especially helpful for those forwarding nodes that are more solicited than others due to their position inside the network. The original messages into several packets such that each node in the network will forward only small sub packets. The splitting procedure is achieved applying the Packet splitting Algorithm. A thorough analytical model that allows us to derive some accurate results regarding energy consumption and complexity. Also, some main considerations about the implementation of the proposed technique in a real sensor network, i.e., by taking into account erasure channels, MAC-layer overhead, and actual computational resources of nodes. Furthermore, the effect of important parameters such as nodes' density and transmission range through both extensive simulations and an analytical study of the tradeoff between energy saving, complexity, and reliability of the proposed technique.

3. CRT-BASED FORWARDING TECHNIQUE

The CRT (Chinese Reminder Theorem) for Data packet id, in which a node starts at a random position, then Applying Prime Numbers to the Data packets for some Security Purpose.

For these purpose intruders won't identify the data packet order. The Chinese remainder theorem is a result about congruence in number theory and its generalizations in abstract algebra. In its basic form, the Chinese remainder theorem will determine a number n that when divided by some given divisors leave given remainders. This module is mainly used for security purpose because it is highly robust.

The Chinese remainder theorem is a result about congruence's in number theory and its generalizations in abstract algebra. In its basic form, the Chinese remainder theorem will determine a number n that when divided by some given divisors leaves given remainders. For example, what is the lowest number n that when divided by 3 leaves a remainder of 2, when divided by 5 leaves a remainder of 3, and when divided by 7 leaves a remainder of 2? A common introductory example is a woman who tells a policeman that she lost her basket of eggs, and that if she took three at a time out of it, she was left with 2, if she took five at a time out of it she was left with 3, and if she took seven at a time out of it she was left with 2. She then asks the policeman what is the minimum number of eggs she must have had. The answer to both problems is 23.

4. PACKET SPLITTING USING PACKET SPLITTING ALGORITHM

The Packet Splitting was the splitting of the packets into various sub-packets and to split the nodes and transmit packets towards the nodes. The original messages are split into several packets such that each node in the network will forward only small sub packets and reconstruct them back. This procedure was achieved by using the packet splitting algorithm. Here we apply Prime Numbers to the Data packets for some Security Purpose. For these purpose intruders won't identify the data packet order.

4.1 Throughput

In communication networks, such as Ethernet or packet radio, throughput or network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. The system throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network. The throughput can be analyzed mathematically by means of queuing theory, where the load in packets per time unit is denoted arrival rate λ, and the throughput in packets per time unit is denoted departure rate μ.

4.2 Packet Delivery Fraction

The packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated from the sources. This performance metric gives us an idea of how well the protocol is performed In terms of packet delivery at different speeds using different traffic models. Mathematically.

$$PDR (\%) = \frac{\sum_{i=1}^{m} \frac{\text{Sum of data packets received by each destination}}{\text{Sum of data packets generated by each source}}}{m} \quad \ldots\ldots (4.3.1)$$

where i, indicates the number of output file

m, indicates the total number of output files

4.3 End to End Delay

End -to-end delay refers to the time taken for a packet to be transmitted across a network from source to destination.

dend-end= N[dtrans+dprop+dproc] …… (4.3.2)

where
dend-end=end-to-end delaydtrans= transmission delay
dprop= propagation delay
dproc= processing delay
N= number of links (Number of routers +
1) Note: we have neglected queuing delays.

Each router will have its own dtrans, dprop, dproc hence this formula gives a rough estimate.

Normalized Routing Load
Normalized Routing Load (or Normalized Routing Overhead) is defined as the total number of routing packets transmitted per data packet.

It is calculated by dividing the total number of routing packets sent (includes forwarded routing packets as well) by the total number of data packets received.

5. ANALYTICAL RESULTS

In this section, we derive some analytical results regarding the proposed CRT-based forwarding method. The main results are briefly summarized as follows.

1) It is shown that by fixing the length of the packet, a maximum value of the number of C RT components, exists above which the energy reduction factor starts to decrease. We explain the reason for this behavior and how to obtain this threshold.
2) The impact of the number of admissible failures, on the ERF and on the network reliability Is evaluated analytically.
3) An analytical model that can be used to estimate the mean energy reduction factor achievable with the Proposed for- warding scheme is derived, and it is proved that, under proper conditions, the proposed Forwarding algorithm is able to reduce the mean energy consumption by about 37%.
4) The overhead due to a possible MAC header is analytically derived.

6. PERFORMANCE EVALUATION

In this section, we compare the performance of CRT in terms of energy consumption to those obtained by SP. Moreover, we provide some results obtained comparing the CRT to the most naive splitting scheme, a simple packet division into chunks. The results have been obtained through a custom MATLAB simulator. We first show a comparison between the results obtained through the analysis and those obtained through the simulator. Then, we analyze some other parameters in order to show the advantages of the proposed technique. Let us consider a sensor network where nodes are randomly distributed in a square area of size m , with density nodes/m . Sensor nodes are assumed to be static as usual in most application scenarios . In each simulation, the sink node is located in the center of the square grid, and each sensor node has a transmission range equal to m . As described in Section IV-D, the network is organized in clusters numbered in ascending order starting from the cluster where is located the sink node, which is identified with. We also assume that events randomly occur in faraway clusters such that. Simulations neglect the effect of collisions and retransmissions at the MAC layer. However, some results performed through the ns-2 simulator [16] show that their impact on the values RS, LT, and Xu codes are those reported in by considering operations carried out on packets of one word each instead of a single packet of sub words.

Table I Simulation Results Obtained

MAC	Mechanism	Packets sent	Collisions	Average Delay
802.11	CRT	1225	3654	4.4 ms
	SP	306	790	4.2 ms
802.15.4	CRT	1545	239	74.1 ms
	SP	618	41	75.5 ms

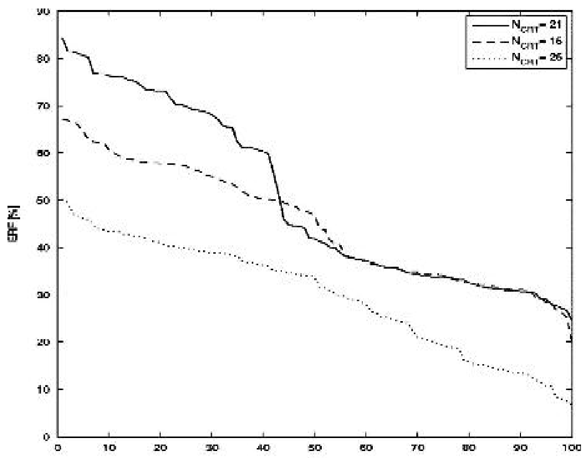

Fig.6.1. ERF versus sorted topologies, with different values of overall delay can be considered of the same entity for the two different forwarding mechanisms.

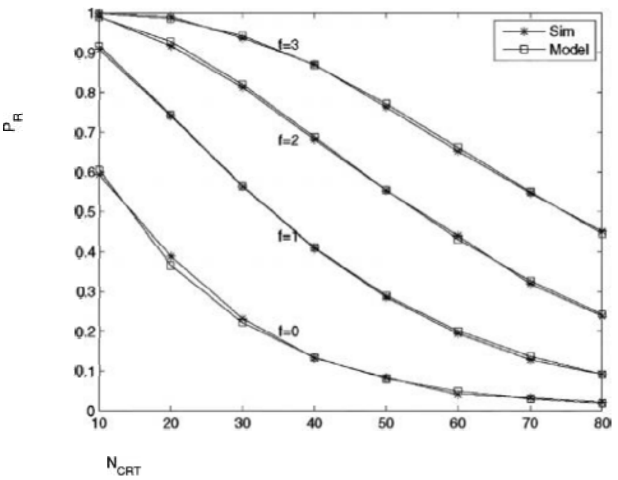

Fig.6.2. Comparison between the values calculated through analytical model and simulation.

The simplest forwarding model involves a packet being relayed from link to link along a chain leading from the packet's source to its destination. However, other forwarding strategies are commonly used. Broadcasting requires a packet to be duplicated and copies sent on multiple links with the goal of delivering a copy to every device to the sink node on the network. In practice, broadcast packets are not forwarded everywhere on a network, but only to devices within a broadcast domain, making broadcast a relative term. Less common than broadcasting, but perhaps of greater utility and theoretical significance, is multicasting, where a packet is selectively duplicated and copies delivered to each of a set of recipients.

7. CONCLUSION

In this paper, we have presented a novel forwarding technique for WSNs based on the Chinese Remainder Theorem (CRT). In particular, we have derived an analytical model able to predict the energy efficiency of the method, and we have especially focused on some implementation issues. First, we have discussed the choice of the CRT algorithm parameters in order to keep the processing complexity low, then we have derived a tradeoff between energy consumption and reliability. Finally, we investigated the overhead introduced in terms of packet header size. Simulation results have confirmed the results obtained analytically and have shown that applying the CRT-based technique significantly reduces the energy consumed for each node, and consequently increases the network lifetime of all the packets in the network.

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