Survey on Packet Size Optimization Techniques in Wireless Sensor Networks

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1. Abstract

Packet size optimization is an important issue in energy constrained wireless sensor networks. As larger size of packets may cause data bit corruption, wireless sensor networks will suffer from higher frequency of re-transmission. As compared to a larger packet size, small size packets are more efficient but creating too short packet size might cause problems, like higher overhead, due to per packet creation overhead and startup energy consumption for each packet. In order to develop energy efficient wireless sensor networks, an optimal size of the packets must be chosen. In this paper we provide a short review of various techniques proposed by researchers in this area of field and evaluate their effect on the performance of wireless sensor networks.

2. Introduction

Wireless sensor network consists of a large number of small sensor nodes spread in a field, which is called sensor field. Sensor field for a particular WSN application is responsible for acquiring environment information collected from different sensor nodes. Sensor node is a small device capable of sensing environment, process the sensed data and transmit it to other sensor nodes or to sink node. Sink node is special type of node that is responsible for gathering all the sensed/processed data from a sensor field and to pass it to any application for further processing. The basic architecture of a typical WSN is depicted in Figure1.

The wireless sensor networks can be used for various application areas, for example military, health, home, education, space, commercial applications etc. Wireless sensor networks are different from other wireless and adhoc networks in many ways e.g.:

1. Number of nodes in WSN are very large than ordinary wireless networks. [1]
2. Sensor nodes are resource constrained as compare to other wireless networks. [1]
3. Sensor nodes are prone to hardware failure. [1]
4. Sensor nodes are broadcasted in environment and their topology varies frequently while this is not the case in most wireless and adhoc networks. [1]
Wireless sensor networks have most of the challenges same as for other wireless networks like (network disconnection problems, network speed problems and low data rates as well) but due to the above mentioned reasons WSNs face few other challenges as well.

1. A fundamental challenge to these small networks is that wireless sensor networks are power constrained networks i.e. the wireless sensor node can only be set with a limited power supply usually less than 1.2 V. In some situations, recharge/refill of power resources (battery) might be impossible. So we can say that lifetime of a sensor node is totally dependant on battery lifetime. [1]

2. In a multihop adhoc sensor network, each node plays the double role of data originator and data router. The improper working of a few nodes can cause considerable topological changes and might require rerouting of packets and reorganization of the network. [1]

Hence, power conservation and power management are more important in wireless sensor networks. Therefore most of the researchers are currently focusing on the design of power-aware protocols and algorithms for designing energy efficient sensor networks. The main task of a sensor node in a sensor field is to detect events, perform quick local data processing, and then transmit the data [1]. Power consumption can hence be divided into three domains:

1. Sensing Information
2. Processing of Information
3. Forwarding/Transmitting data towards sink node.
From all of these three operations most of the energy/power is consumed in transmitting the data towards sink node. So for creating energy efficient wireless sensor network most of the researchers work on this part of field. In order to identify power consumption at each node it is important to identify the factors that cause more power utilization. Such factors can include: type of modulation used, data transmission rate, transmit power determined by transmission distance, packet payload size, header size, amplifier power, reception power, startup power, and startup time etc [2].

In a wireless sensor network packet size has the direct effect on reliability and performance of communication between wireless nodes, so there is need to have an optimal packet size for wireless sensor networks. For instance having long packet size in a WSN network can cause data bits corruption and in turn increases the data packets retransmission [3]. As we know that most of the power in a wireless sensor network is consumed in data transmission towards sink node; so having longer packet size in WSN will ultimately cause the data bits corruption and increase re transmission rate and that will affect the overall efficiency of WSN.

On the other hand, short packet sizes may increase data transmission reliability since the chances of bit errors over the link are less, but too short a packet size may not be efficient in the context of data payload carrying capacity because of the standardized data packet overhead [3]. Also packet management at each node will become difficult.

There are many techniques developed yet to get an optimal packet size for the wireless sensor networks most of which are suggesting that there must be a fixed packet size as in [4]. Few others are promoting the use of dynamic packet length [5] i.e. variable size of data packets in a wireless sensor network. In this survey report a number of techniques have been discussed for obtaining a suitable size of data packets in wireless sensor networks and finally we have given a conclusion mark on each technique.

3. Techniques Used For Packet Size Optimization for Wireless Sensor Networks

Various techniques by different researchers have been proposed for the packet size optimization in wireless sensor networks. Mainly those approaches are either fixed size packets approach or variable size packets approach. In this section we will discuss these approaches in detail.

3.1 Fixed Size Packets in Wireless Sensor Networks

In [4] they have used fixed size data packets to be used in a wireless sensor network. According to them, although variable packet size will increase the channel throughput and enhance the wireless sensor networks’ transmission mechanism but simplicity of such autonomous system is also compromised, and these resource constrained networks will ultimately suffer from overhead of resource management while having variable size
data packets. So they have chosen fixed sized data packets for energy efficient wireless sensor networks. There are basically three fields in a data packet:

1. Packet Header
2. Payload/Data Segment
3. Packet Trailer

They identified each field and recognize that as packet header contains many fields that are usually less important for wireless sensor network’s nodes and removing those will ultimately shorten the packet size in a WSN. Those fields include current segment number, total number of segments, packet identifiers and source and destination identifiers [4].

In [6] they have recognized an optimal packet size for a wireless sensor network and measured its efficiency in terms of overall energy consumption and throughput and other network performance parameters as well. In figure 2 below the overall proportion of packet size and retransmission rate is depicted that took place in a wireless sensor network. Hence increased retransmission will affect the network performance like it reduces the overall throughput of a link, so we can say that packet size also affects the overall network performance parameters as well.

![Graph showing proportion of packet size with retransmission rate in WSN](image)

**Re-Transmission Rate**

Figure 2: An observational graph showing proportion of packet size with retransmission rate in WSN
3.2 Variable Size Packets in Wireless Sensor Networks

According to [5] variable packet size in wireless sensor networks plays an important role and they have developed a scheme DPLC (Dynamic Packet Length Control) in this regard. DPLC technique uses variable length packets for a wireless sensor network. It works intelligently and will create variable sized packets based on channel condition. If channel is noisy (means it is congested having a lot of packets) it will generate shorter packets. While in a quiet channel (i.e. it is almost empty) larger sized packets will be generated. In this way their technique enhances overall throughput and efficiency.

In [7] they have used Kalman Filter for developing optimal frame size predictor. They have developed this scheme on the MAC layer for a wireless sensor network. Their work enhances the energy consumption mechanism in a Wireless Sensor Network by optimizing frame size for a WSN network.

3.3 Packet size Optimization Frameworks

Different frameworks from various researchers have been developed for generating/getting optimal packet size for an energy efficient wireless sensor network. Recently in this regard a framework is developed [8] for packet size optimization in wireless sensor networks. They demonstrated that longer packet size is more suitable than shorter packet size in certain cases. But sometimes they may cause lack in efficiency in wireless sensor networks so there must be a framework that identified different criteria for finding optimal packet size in a wireless sensor network. Their developed framework is used to investigate the various performance metrics such as throughput, energy consumption per bit, latency, and packet error rate [8].

4. Packet Size Formats Used In Different Techniques

Various packet sizes have been proposed by different researchers for wireless sensor networks. According to [9] small packet size will create more energy efficient wireless sensor networks if overhead of each packet is ignored. Counting per packet overhead created in a wireless sensor networks will ultimately favor large sized packets for this type of resource constrained tiny sensor nodes. So it depends on overhead produced by each packet generation. Their suggested packet size could be determined from the table below.
Figure 3: Effect of packet size on the ESB (Re-produced from [9])

Other packet formats designed by the researchers for energy efficient wireless sensor networks used various existing packet formats for other types of networks and analyzed their effect using Simulators for wireless sensor networks. According to [10] there are different header formats and researchers could use any of those built-in formats for designing their own packets. They have designed their packet header using common header format that is shown in figure 4.

Figure 4: Packet header format used in [10] (Re-produced from [10])

In [4] they illustrated the overall packet format as in figure 5 and depicted that header is the only best option that could be minimized in size as it contain many fields that contain information that is usually useless for routing packet in a WSN network so removing such fields from header will significantly shorten the overall packet size and according to
them smaller size is more effective for creating energy efficient Wireless Sensor Networks.

![Packet format used in [4] (Re-produced from [4])](image)

5. Conclusion

Packet size is an important factor for creating energy efficient wireless sensor networks. In this regard various approaches have been conducted by different researchers and various techniques and frameworks have been developed in this field. According to the survey above there are few techniques that promote fixed sized packets for data transmission in sensor node, while other promote variable size of data packets to be sent by each node according to the channel capacity. The former approaches are simpler to be implemented and posses less overhead but they are inefficient with regard to energy efficiency, overall throughput and performance. While the latter approaches are promising with respect to energy efficiency, throughput and performance but posses a lot of overhead at each node to manage the packet size calculations and other issues. Still there is a need to have an optimal approach that combines the benefits of both approaches and to eliminate the drawbacks of each.

6. Reference


