COORDINATED SLEEP SCHEDULING ALGORITHM USING ENERGY EFFICIENT IN MANET

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Abstract

This paper presents a target coordinated based sleep scheduling algorithm to enhance the energy efficiency for a mobile target tracking surveillance sensor network. The working node reducing efforts and the sleep scheduling, achieves the energy efficiency but suffers little performance loss. For the Coordinated sleep scheduling, we consider the target's moving direction when defining the tracking subarea to imitate the actual object's motion more likely. In this paper, we focus on improving the security and data loss problems along with increased detection time, malicious node, false positive and negative.

Keywords: Energy Efficient, Sleep Scheduling, Layer, Routing, Coordinated, Wireless.

1. Introduction

Unlike wired networks or cellular networks, a wireless ad hoc network has no fixed networking infrastructure. The basic components of the wireless ad hoc networks architecture are nodes with the capability of wireless communications. As shown in Figure1, a wireless ad hoc network is a collection of multiple nodes that maintain the network connectivity through wireless communications. In wireless ad hoc networks, each node may communicate directly to others. Due to the limited transmission range of radio, pairs of nodes that are not directly connected need intermediate nodes to forward their traffic. Every intermediate node acts as a router to forward packets for other nodes in the case of multi-hop connections.

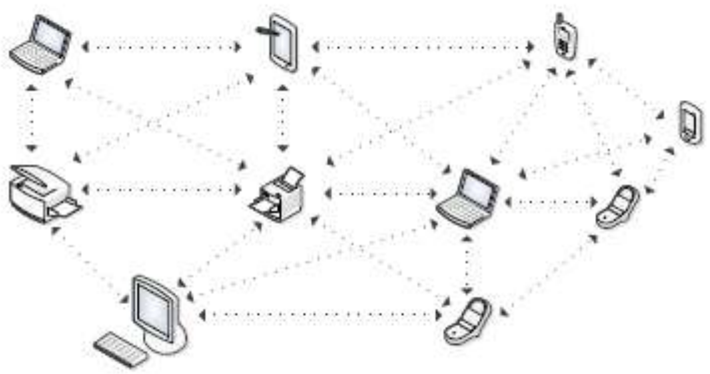

Figure 1: Illustration of Wireless Adhoc Network Architecture

Compared with traditional infrastructure-based wireless networks, such as cellular networks and wireless local area network (WLAN), the main advantages of wireless ad hoc networks are exibility, low cost and robustness. These characteristics of ad hoc networks initiate a variety of applications and systems. Initially, wireless ad hoc networks were mainly studies in the realm of military or disaster relief situation. More recently, wireless ad hoc networks have also been envisioned for commercial application such as providing Internet connectivity for nodes that are not in the transmission range of a wireless access point. Generally, the field of wireless ad hoc network contains several subfields including mobile ad hoc network (MANET) such as in military communications where all nodes are assumed to be mobile, wireless mesh network (WMN), a combination of ad-hoc and infrastructure network, wireless sensor network (WSN) made up of sensor nodes for monitoring and tracking, and vehicular ad hoc network (VANET) specially for vehicle communications. Wireless ad hoc networks normally consist of computing devices powered by battery. Thus, the design of an energy-constrained wireless ad hoc network poses a critical challenge related to the energy budget. The ongoing research is mainly concentrated on solutions that use the minimum possible energy during communications, thereby prolonging the device operation lifetime. In this thesis, we focus on two separate but equally important fronts of power-saving mechanisms: sleep scheduling in the link layer and energy-efficient routing in the network layer. In the following, we first provide the power consumption analysis of the wireless interface at a node, and then introduce two basic techniques and analyze their offered benefits of energy savings.

Normally, the wireless interface hardware at a node can operate in any of four different modes: (1).Transmit mode when a node transmits a packet; (2).Receive mode when a node receives a packet; (3).Idle mode when a node is not transmitting or receiving a packet. This mode consumes power because the wireless interface must be up and ready to receive any possible traffic; (4).Sleep mode when a node powers of the wireless interface hardware and therefore it can neither transmit nor receive packets. Measurement results have shown that the wireless interface consumes the highest power in the transmit mode and very little power in the sleep mode. The power consumed in the idle mode is however comparable with the power required for the receive mode. For instance, Cisco Aironet Wireless CardBus Adapter typically consumes 1.78W, 1.08W, 0.67W and 0.02W in the above four modes respectively. For wireless ad hoc networks, there are mainly three sources of non-essential energy expenditure. The first source of energy waste is collisions as a result of random access. In shared-medium wireless networks, there is a high opportunity for packet transmission collisions to occur. When a transmitted packet is corrupted due to collisions, it has to be discarded and retransmissions of the packet cause extra energy. One fundamental target of the MAC protocols is to avoid collisions from interfering nodes. TDMA MAC has the natural advantage of energy saving compared with the contention-based protocols by eliminating collisions. The second source is referred to as idle listening, which corresponds to the energy consumed in the idle mode. When the total traffic load over the network is relatively low, nodes are assumed to be operated in the idle mode for a long time. For instance, most sensor networks generating very light traffic are designed to operate for a long time. Thus, idle listening is a dominant factor of energy waste in such cases. The third source of energy waste is overhearing, during which nodes receives control or data packets that were not transmitted to them. Unfortunately, in a wireless ad hoc network, it is frequently the case that a packet transmission from one node to another will be overheard by all the neighbors of the transmitter. These nodes will consume power needlessly even though the packet is not directed to them. The reason is that the wireless interface does not have any mechanism to not receive that packet. Note that energy consumed by overhearing is the same as that in reception. It is hence a significant waste of energy, especially when node density is high and traffic load is heavy.

Sleep Scheduling in the Link Layer

According to the power consumption analysis at a wireless node, powering of the wireless interface can greatly reduce the energy consumed by idle listening and overhearing. Consequently, sleep scheduling (also called duty-cycling) is commonly adopted as a link-layer power-saving mechanism in the wireless ad hoc networks. This mechanism allows nodes to enter the low-power sleep mode by turning of the wireless interface whenever there is no communication demand. By doing this, the channel time is divided into sleep periods and active periods, as Figure 2 shows. In the sleep period, a node powers of its wireless interface in order to save energy. At the beginning of each active period, the node wakes up and gets ready to transmit. An important concern related to sleep scheduling is whether the delay or throughput behavior is deteriorated. Therefore, the crucial issue in the design of sleep scheduling protocols is to strike a trade-off between the overall performance and power saving. Extensive efforts can be classified into coordinated scheduling and random scheduling (also called asynchronous scheduling). Generally, coordinated sleep scheduling approaches can potentially achieve better performance with the centralized coordination of sleep schedules than random scheduling.

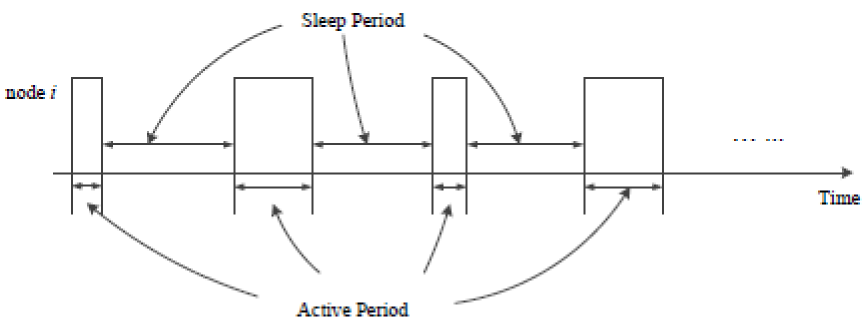

Figure.2: An Illustration of Operation Sleep Scheduling

Energy efficient Routing in the Network Layer

Energy efficient routing is proposed to reduce end-to-end transmission energy cost of data communications in wireless ad hoc networks. Different routes consist of different nodes in the topology and hence determine a unique transmission path related to energy resources. Typically power-aware routing protocols select a path connecting a pair of source and destination node that minimizes the total transmissions power over all the nodes in the selected path. Most existing power-aware routing protocols assume that wireless links are reliable. However, in wireless networks, various factors like ambient noise, fading and interference can lead to packet losses due to transmission errors. A retransmission mechanism is commonly employed in the link layer to recover from packet losses. Therefore, the total transmission power associated with a pre-selected path in the power-aware routing protocols fails to capture the actual energy spent in packet delivery considering potential retransmissions. Energy efficient reliable routing protocols that take account of the quality of wireless links are hence proposed to find best paths requiring less number of retransmissions. It is worth to mention that those best path routing (BPR) protocols all follow a conventional design principle of traditional wired networks: the best routes are predetermined before data transmissions and all data flows from the source and destination follow the selected routes until the path is updated. Opportunistic routing (also called any path routing), an integrated routing and MAC technique has recently overturned this principle. Instead, opportunistic routing protocols allow multiple forwarders to opportunistically deliver packets to the destination, accounting for their time-variant channel conditions. The general idea of OR is that, for each destination, a set of next-hop candidate forwarders are selected and prioritized. When a data packet is to be forwarded, the highest priority node among candidates that received it will be chosen as the next-hop. It leverages the wireless broadcast advantage (WBA) to mitigate the impact of packet losses: the packet transmission for a node can be heard by its neighboring nodes, so that the probability of successful reception by at least one node within these forwarders can be much higher than that of just one fixed next-hop. It is envisioned that OR avoids retransmissions as long as the packet makes forward progress towards the destination and thereby reducing the total energy consumed. OR protocols are confirmed to outperform BPR protocols in terms of the total energy consumption with lossy broadcast links. One fundamental issue in designing an energy efficient OR protocol is how to select and prioritize the forwarder list to minimize the total energy cost.

2. Proposed Algorithm

Coordinated Sleep Scheduling

We assume that the wireless nodes are capable of powering of the radio interface during a certain period within a time slot. This allows a node to enter the low-power sleeping mode when it does not have a packet to send or to receive. In this study, we adopt the function of coordinated sleep scheduling to facilitate the routing operations with respect to BPR and OR protocols, respectively. In the adopted sleep scheduling protocol, a time slot is divided into two periods, namely WAKE and DATA periods, respectively. Generally, all the nodes wake up at the beginning of the WAKE period in one time slot. During the WAKE period, transmitters with the communication demand send a signaling packet of traffic indicator to inform its intended receiver nodes. Meanwhile all other nodes keep listening to the channel for the possible traffic indicator from any of the neighbors. During the DATA period, all the nodes are allowed to power of the radio interface when it does not have a packet to send or to receive in this time slot. Such coordinated sleep scheduling protocol has been widely discussed in research on periodic sleep scheduling.

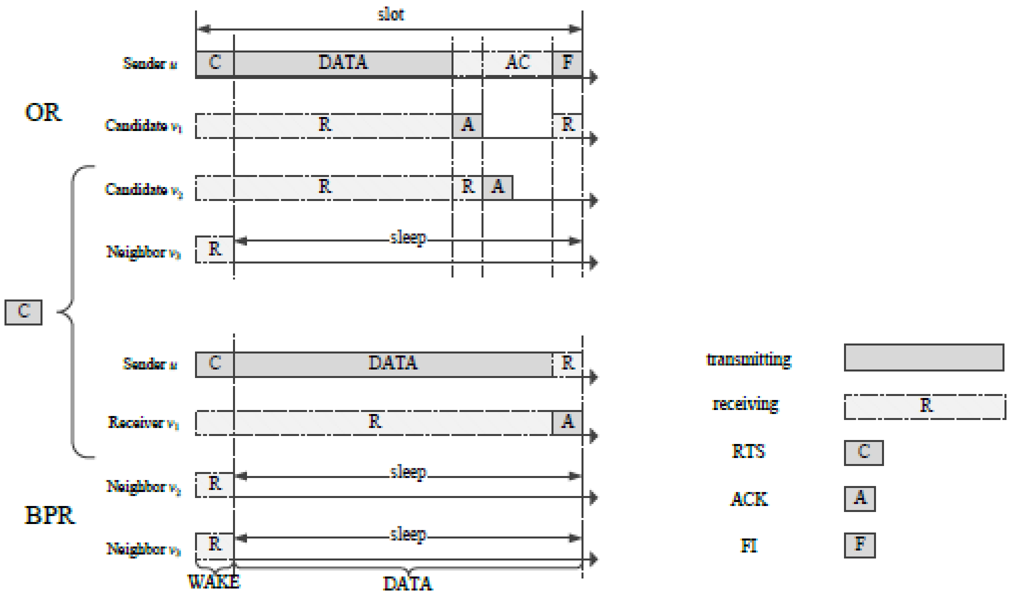

Figure 3: A timing diagram illustrating the routing operation within a single time slot

WAKE Period: When a data packet is ready for transmission, sender u transmits an RTS signalling packet with packet length LBPR RTS or LOR RTS regarding the different routing protocols, and all the nodes within its broadcast range v1; v2; v3 are required to receive the packet. It contains the forwarder list and their priorities. Note that for BPR protocols, only one forwarder is specified in the field of RTS. **DATA Period:** During the DATA period, a data packet with packet length Ld is transmitted. The routing operation varies with respect to different routing protocols. In the following, we present the detailed operation of BPR and OR, respectively.

- BPR Packet Transmission: Sender u unicasts the data packet to the specified receiver node, v1, while nodes v2 and v3 turn of their radio during the rest of time slot to preserve energy. Only node v1 is required to receive the data packet. After an ACK responded from receiver v1 is received at node u, the data transmission is complete. Otherwise, sender u will retransmit this data packet in the next available time slot.
- OR Packet Transmission: Sender u multicasts the data packet to the multiple candidate nodes specified in the forwarder list fv1; v2g. Node v3 then turns of the wireless interface to enter the sleep mode as it is not involved in the data transmission in this time slot. Here we introduce a TDMA-like approach in AC period for the OR protocols based on. When an intended candidate receives the data packet, it responds by an ACK packet. These ACK transmissions are deferred in time in an order of their priorities. The first candidate with the highest priority transmits the ACK as soon as it

successfully receives the data packet, the second one after a period equal to the time to transmit an ACK, and so on.

- Finally, sender u transmits an FI message that indicates the node v1 to take the responsibility of forwarding the packet. The packet length of FI message is denoted as LFI . The duration of AC period is predefined according to the maximum candidates Cm that can be used for practical considerations.

We assume that signaling packets, such as RTS, ACK and FI, with a small packet length are not subject to transmission errors, while data packet transmissions in general encounter link failures. It is worth to mention that those assumptions are made mainly for simplicity of the calculations of the expected energy cost in the following. Since the packets are relatively short, it is reasonable to assume that the channel remains relatively constant for the entire time slot.

3. Experimental Results

Detection Time

Energy Efficient Neighbor Coverage Protocol(EENCP)	Secure Enhanced Adaptive Acknowledgement(SEAACK)	Probability Based Prediction and Sleep Scheduling(PPSS)	Proposed
550	350	600	240
690	280	780	320
750	450	800	600
880	500	950	530
920	690	1030	800

Table 1: Comparison table of Detection

This table describes the comparison of detection time of three existing method that is EENCP, SEAACK, PPSS method and proposed method. Comparing these four methods we assume that proposed Method shows minimum values of detection time from 240 to 800. Whereas the other three shows a maximum detection values less than proposed method.

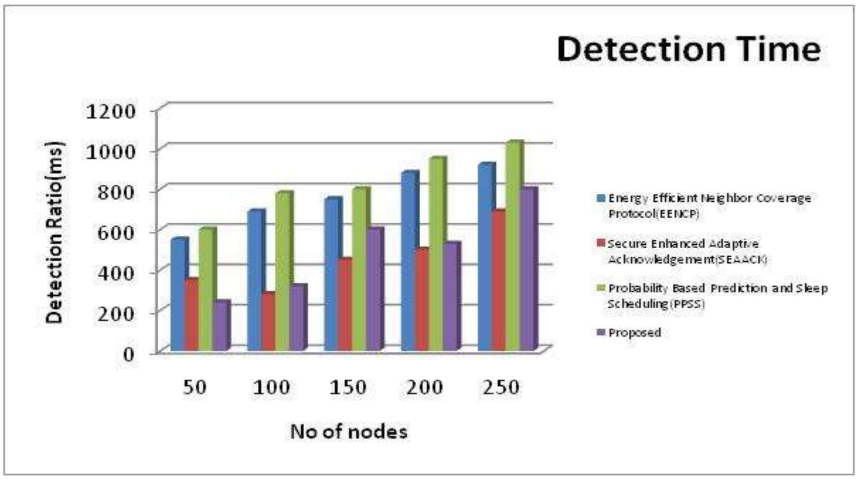

Figure 4: Comparison Chart of detection Level

This chart explains about the detection level of three existing methods and one proposed method. The variations of its range is been explained using no. of nodes in X axis and the detection ratio of the process in Y-axis. While analyzing and comparing proposed method with existing method, proposed Method shows minimum values of detection time from 240 to 800. Whereas, the other three existing methods involves more detection ratio.

False Positive

Energy Efficient Neighbor Coverage Protocol(EENCP)	Secure Enhanced Adaptive Acknowledgement(SEAACK)	Probability Based Prediction and Sleep Scheduling(PPSS)	Prop osed
710	600	1000	500
790	650	1290	599
830	780	1450	810
1100	800	1610	1000
600	400	1700	499

Table 2: Comparison table of False positive ratio

This table describes the comparison of false positive ration of three existing method that is EENCP, SEAACK, PPSS method and proposed method. Comparing these four methods we assume that the false positive ratio of proposed method is less when compared to existing methods.

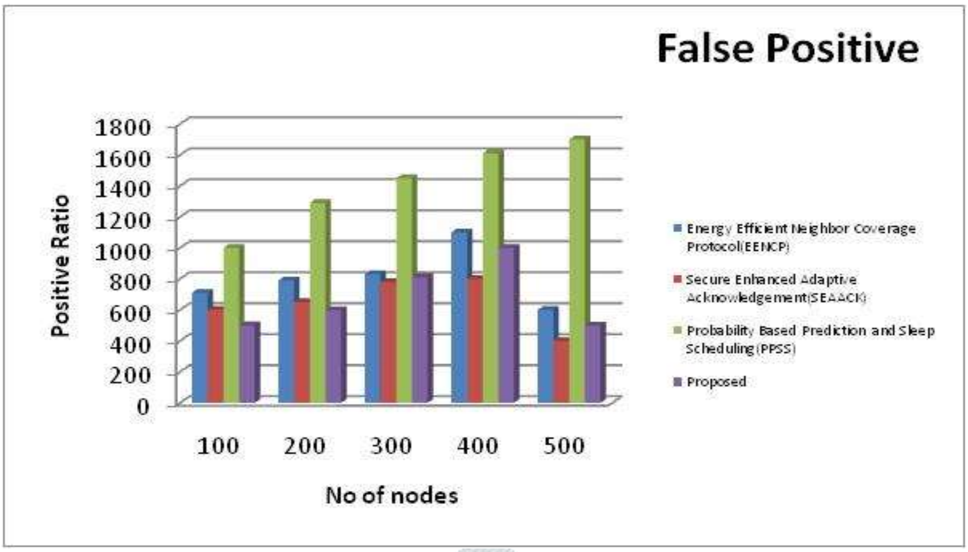

Figure 5: Comparison chart of false positive

The comparison chart explains about the false positive ratio of three existing methods and one proposed method. The variations of its ratio is been explained using the positive ratio in Y axis and no of nodes in X-axis. The graph displays the comparison of false positive ratio on the proposed and three existing methods. The false positive of ratio in proposed method is less in minimum 499 to maximum 1000 when compared to other existing methods.

Impact of False Positive

Table 3:

Comparison table of Impact of false positive

Energy Efficient Neighbor Coverage Protocol(EENCP)	Secure Enhanced Adaptive Acknowledgement(SEAACK)	Probability Based Prediction and Sleep Scheduling(PPSS)	Proposed
500	1100	1000	489
650	1400	1320	620
790	1500	1450	750
900	1700	1699	888
1400	1900	1850	1300

This table describes the comparison table of impact of false positive ratio of three existing method that is EENCP, SEAACK, PPSS method and proposed method. Comparing these four methods, we assume that the performance of proposed method shows less impact of false positive value from 489 to 1300. Whereas the other three shows a maximum impact of false positive ratio than proposed method.

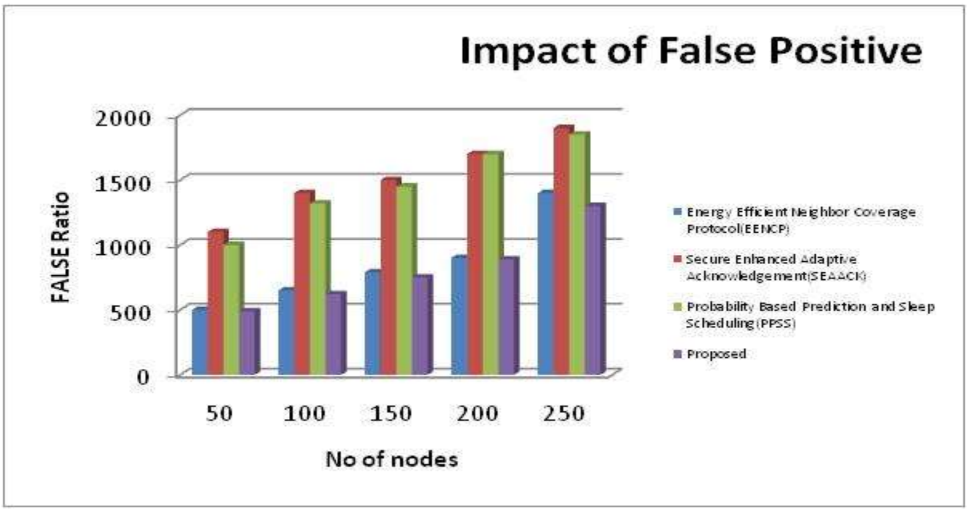

Figure 6: Comparison Chart of Impact of False positive

The comparison chart explains the Impact of false positive ratio of existing methods and proposed method. This shows that proposed method process the impact of false positive ration from 489 to maximum 1300. Whereas, the ratio level of three existing methods EENCP, SEAACK, PPSS shows maximum number of false ratio when compared to proposed method.

Impact of Malicious Node

Energy Efficient Neighbor Coverage Protocol(EENCP)	Secure Enhanced Adaptive Acknowledgement(SEAACK)	Probability Based Prediction and Sleep Scheduling(PPSS)	Proposed
790	550	500	430
850	650	600	580
910	750	735	625
980	850	800	788
1100	950	901	850

Table 4: Comparison Table of Impact of malicious node

This comparison table describes the Impact of malicious node of three existing methods EENCP, SEAACK, PPSS and proposed method. Comparing these four methods we assume that the ratio of impact of malicious ratio in proposed method is less from 430 to 850. The existing method shows a maximum impact of malicious node than proposed method.

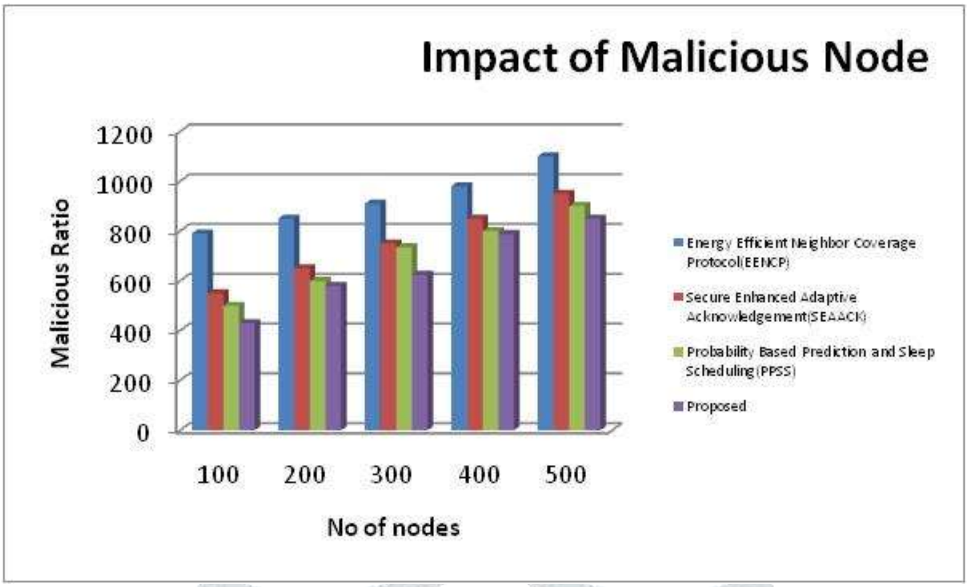

Figure 7: Comparison Chart of Impact of Malicious node

Comparison chart explains about the Impact of malicious nodes of three existing Methods and one proposed method. The comparison of these four methods is been explained using the number of nodes in X axis and its malicious ratio in Y-axis. The stability level of proposed method is less from 430 to 850, when compared to existing methods.

Conclusion

We present the simulation-based evaluation of different energy efficient routing protocols with and without the function of coordinated sleep scheduling. We consider extensive system performance metrics based on the total energy consumption, throughput, and packet delay, as well as energy consumption per packet. The results show that coordinated sleep scheduling has an impact on the energy efficiency achieved by different routing protocols. First, we evaluate the impact of traffic load over the network on the overall performances. When the channel condition is relatively good as a result of the lower traffic load, the EEOR protocol cannot guarantee a higher energy efficiency as compared with the MHR protocol. Then, evaluation of the node density impact on the overall performances shows that MHR even outperforms EEOR in term of energy efficiency in high node density scenario. Despite the improvement of packet delivery probability achieved by multi-receiver diversity gain in OR protocols, the effect of increased energy consumption at potential forwarders should be taken into account when coordinate sleep scheduling is supported.

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