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Improvising Vehicle Health using E-BMA MAC Protocol in Wireless Sensor Networks

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Abstract: Recent advances in wireless sensor networking (WSN) techniques have inspired interest within the development of vehicle health watching systems. Energy potency is one amongst the foremost vital factors for the WSNs. In earlier analysis, associate degree energy-efficient cluster-based accommodative Time-Division Multiple-Access (TDMA), Medium-Access-Control (MAC) protocol, named Energy Adaptive Time-Division Multiple Access (EA-TDMA), has been developed by the authors for the aim of communication between the sensors placed in every vehicle wagon. This paper proposes another new protocol named ENERGY-EFFICIENT E-BMA that achieves even higher energy potency for low and medium traffic by minimizing the idle time throughout the rivalry amount. In addition to vehicle applications, the EA-TDMA and E-BMA protocols square measures appropriately for generic wireless digital communication functions. Each analytical and simulation results for the energy consumption of TDMA, EA-TDMA, BMA and E-BMA are bestowed during this paper to demonstrate the prevalence of the E-BMA protocols.

Key words: Energy efficiency · Medium Access Control (MAC) protocol · Vehicle Health Monitoring (VHM) · Wireless Sensor Networks

INTRODUCTION

Wireless Sensor Network: A wireless sensor network (WSN) consists of spatially disseminated autonomous sensors to *monitor* physical or environmental conditions, to pass their data through the network to a main location [1]. A sensor network is composed of a large number of sensor nodes (as in fig:1), which are densely deployed. The number of nodes in a sensor network can be several orders of magnitude higher than the nodes [2]. Sensor nodes are limited in power, computational capacities and memory [3]. In the recent years, the rapid technological advances in small electro-mechanical systems, low power and extremely integrated digital natural philosophy, tiny scale energy provides small microprocessors and low power radio technologies have created low power, low cost and multifunctional wireless sensing element devices [4]. These devices will collect the information by sensing the close conditions in its neck of the woods and send the perceived knowledge to the sink or base station on the pre-established routes through multiple wireless hops.

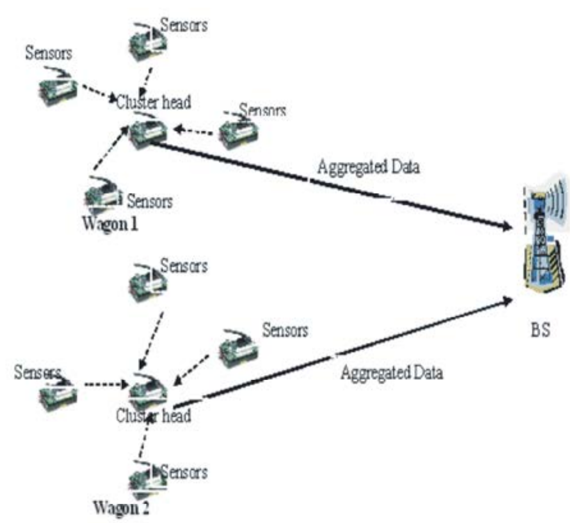

Fig. 1: A typical wireless sensor network

The sensing elements run on a little battery, a tiny chip, a radio transceiver and a set of transducers. Typically these sensor square measure the equipped with processing and communication capabilities [5]. The emergence of those low price and small sized wireless

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sensing element devices has motivated intensive analysis within the last decade that addresses the potential of collaboration among sensors in knowledge gathering and process, that light-emitting diode to the invention of Wireless Sensor Networks (WSNs). With the increasing sensing element networks, it has a tendency to envision them to be multipurpose with sensing element nodes that exploit their multiple sensing capabilities to serve various applications like target pursuit for the military, surround watching in forests, detecting wetness levels in agriculture, watching the statistics of the patient in health, watching transport and traffic monitoring, building and industrial monitoring, explosion detection, intrusion detection, so on [6]. However, the sensing element output of every application anticipates a knowledge delivery service from the network infrastructure. For instance, the knowledge of a possible chemical leak is more necessary than knowing that everything is ok and also the information ought to be extremely reliable with an occasional latency [7].

Similarly, in forest watching applications [8], the sensing element knowledge that contains an abnormally extreme temperature ought to be delivered to the bottom station which are high dependable in limited time length, since it is mostly proof of a fireplace. On the other hand, the temperature information that is within various traditional temperature levels are often delivered to the bottom station with a certain delay and loss share. The time period application in conjunction with the introduction of imaging and video sensors, has posed extra challenges. For example, the transmission of imaging and video knowledge needs careful handling so as to confirm that end-to-end delay is within the suitable range in which the variation delay is appropriate. These examples manifest that sensing element network applications have periodic (non real time: NRT) and demanding knowledge (real time: RT). Vital knowledge is delay sensitive and it is to be delivered to the bottom station with high dependence. So, immediate remedial and defensive actions are often taken [9]. Whereas, periodic knowledge is delay tolerant and a definite loss percentage is tolerable on delivery.

The delay and reliability square measure the performance metrics and square measure sometimes noted because the QoS needs of the critical knowledge [10]. Therefore, power strained sensor networks for real time applications demand energy and QoS aware routing protocol to deliver vital knowledge with low latency and high reliability. Thus, QoS routing is a vital topic in sensing element network analysis and also the WSN analysis community has centered thereon [11]. This paper in short reviews the varied QoS based mostly routing protocols that are projected for the WSN to that of an E-BMA based protocol routing. In we have a tendency to gift the taxonomy of routing protocols supported the protocol operation.

Problem Statement: A basic barrier to achieving acceptable levels of performance in large-scale WSNs is energy potency. Wireless sensors have restricted energy provide and square measure typically deployed in environments wherever recharging is either not possible or too pricey. As an example, for a WSN resolution to be possible for repository establishments like national museums, electric battery operated sensing element node, deployed among every exhibit, should have a time period of 3 years. National museums square measure typically terribly giant and thus, tens of many thousands of sensors square measure required to watch the setting conditions in every exhibit.

Protocol style for WSNs has received much more attention than different style problems. Protocol style tries to boost energy potency by accepted a trade-off on different aspects of network performance, like information measure potency, latency and QoS. Energy-aware networking protocols will offer larger energy consumption reduction than optimization of the hardware. Algorithmic modifications will usually lead to vital energy savings [12]. It's acknowledge that communication of information over wireless links consumes far more energy than sensing and processing.

The energy potency needs of WSNs create a good challenge for Medium Access management (MAC) protocol style. Recent studies have projected many WSN-specific energy-efficient waterproof schemes. Waterproof schemes for wireless networks square measure typically classified into 2 Categories, contention-based and contention-free. Contention-based schemes square measure wide applied to unintended wireless networks as a result of simplicity and an absence of synchronization needs. Such Associate in nursing example is that the IEEE 802.11 wireless local area network normal, that is meant for minimum delay and most output. Ancient contention-based schemes need sensing element nodes to stay their radios on to receive potential incoming messages.

Therefore, such schemes don't seem to be energy-efficient owing to idle listening. Contention-free schemes, referred to as reservation-based or scheduling-based schemes, try and sight the neighboring radios of every node before allocating collision-free channels to a link. Time Division Multiple Access (TDMA) is Associate in nursing example of a contention-free theme.

The major sources of energy waste square measure idle listening, collision, overhearing and management packet overhead. The radio of a sensing element node will operate in four completely different modes: Transmit Receive, Idle and Sleep. Idle listening dissipates tidy energy, virtually adequate 50-100% of the energy consumed in receive mode. A collision happens once a transmitted packet is destroyed and retransmission is needed [13]. Overhearing refers to the condition that a node receives a packet sent to others. The management packet overhead is that the energy consumed in sending the management packet.

The use of TDMA-based waterproof schemes is viewed as a natural alternative for sensing element networks as a result of radios are often turned off throughout idle times so as to conserve energy. Additionally, dividing the sensing element network into non-overlapping teams of nodes, a method brought up as agglomeration, is an efficient technique for achieving high levels of energy potency and quantifiability. Agglomeration solutions square measure usually combined with TDMA-based schemes to scale back the value of idle listening. A cluster-based technique, LEACH, applies TDMA among a cluster. The whole network is split into non-overlapping clusters. There’s a cluster head among every cluster. Rather than sending the information to the bottom station directly, the sensors send their information to the cluster-head.

The cluster head relays the information to the worldwide base station. LEACH indiscriminately rotates the cluster head to distribute the energy consumption equally among all sensors within the network. LEACH assumes all nodes have information to transmit to the cluster head in any respect times [14]. Below this condition, TDMA planning uses the information measure with efficiency.

TDMA-based solutions typically perform well below high traffic load conditions. A high traffic load means that all nodes continuously have information to transmit, that isn't a natural behavior for event-driven applications. With typical TDMA, once a node has no information to send, it still needs to activate the radio throughout its regular slots. Below this condition, the node operates in idle node that is Associate in nursing energy-consuming operation. The Energy-efficient TDMA (E-TDMA) extends the traditional TDMA to scale back the energy consumption owing to idle listening: once a node has no information to transmit, it keeps its radio off throughout its allotted time slots. However, the cluster head needs to carry on the radio throughout all the time slots [15]. Once there's no incoming packet throughout Associate in nursing idle interval, the cluster head operates within the idle mode and wastes energy. Additionally, dynamical the interval allocations and frame lengths dynamically in step with the unpredictable variations of sensing element networks is sometimes laborious for TDMA-based schemes [16].

In this paper, we have a tendency to 1st propose Associate in Nursing energy-efficient and strong intra-cluster communication bit-map power-assisted (BMA) waterproof protocol for large-scale cluster-based WSNs so derive 2 completely different energy analytical models for BMA, typical TDMA and energy economical TDMA (E-TDMA) once used as intra-cluster waterproof schemes. BMA is meant for event-driven sensing applications, that is, sensing element nodes forward information to the cluster head given that vital events square measure ascertained [17]. Additionally, BMA has low complexness, its planning changes dynamically in step with the unpredictable variations of sensing element networks and reduces the energy wastes owing to idle listening and collisions whereas maintaining a decent low latency performance.

Protocol Description

BMA: The E-MBA protocol has many rounds and each of which constitutes a setup phase and a energy efficient-steady- state phase. The latter comprises a contention phase and a data transmission phase. The cluster formation occurs in the setup phase. The cluster head selection also done in this phase. Energy effiency is achieved in the energy-efficient-steady state phase by the following:

- Local aggregation
- Cluster head aggregation

Setup Phase: Let us assume that the network consists of multiple fixed clusters based on the application. Each cluster contains a cluster head (CH) located at the center of every cluster. Based on the application and cluster size, direct transmission for data communication between source nodes and the CH is considered instead of multihop data transmission. In the setup phase, the CH informs all nodes about the start of the current round, frame start/stop time and number of frames in a round.

Contention Phase: Each node is assigned a specific slot in the contention phase. A node transmits a 1-bit control message during its scheduled slot to reserve a data slot if it has a data packet to transmit; otherwise, the node remains in sleep mode during that contention slot. After the contention period is completed, the CH sets up and broadcasts a transmission schedule for the source nodes. However, unlike BMA, the source node does not make the reservation immediately after the data becomes available. Instead, the source node keeps the data packet in the buffer and it waits for one frame duration to see if there is a consecutive data packet to send.

Data Transmission Phase: The data transmission phase contains one or more frames. The size and duration of each frame is fixed. Nodes send their data to the CH at most once per frame during their allocated time slot. During the data transmission phase, each source node turns on its radio in its allocated data slot and transmits data to the CH. If there are consecutive packets, the transmitted data packet conveys that information through piggybacking.

Local Aggregation: After piggybacking is done each of the nodes does local aggregation to increase the efficiency. It organizes all the collected data and removes the unwanted and unclear data before sending it to the cluster head. Thus it increases efficiency by reducing the data to a considerable amount and thus the power required to transfer these data is being saved.

Cluster Head Aggregation: After receiving all data from the nodes of a round, data aggregation takes place to reduce unwanted data. A considerable amount of energy is saved if the data are aggregated in the CH rather than when sending the data to the BS or central controller and aggregating them in the BS. Once the CH is ready to send the aggregated data, it must sense the channel to see if anyone else is transmitting using the BS spreading code. The CH waits if the channel is busy; otherwise, the CH transmits data to the BS [18]. After a predeffned time, the system begins the next round and the whole process is repeated. Since double aggregation is done locally in each of the nodes and the cluster head energy efficiency is achieved by the proposed method.

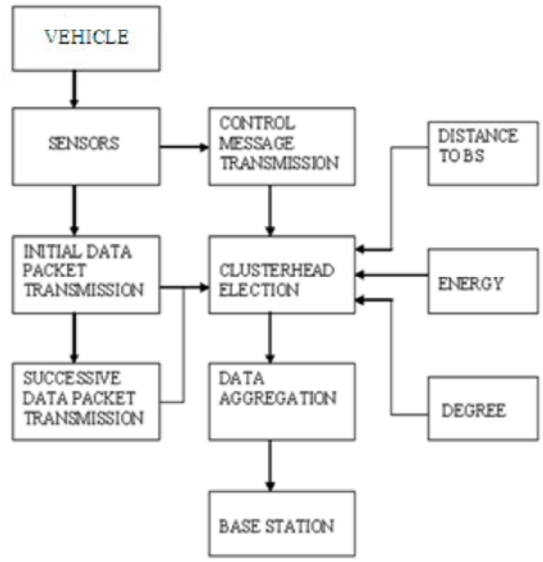

Fig. 2: Architectural Diagram

CONCLUSION

The energy performance of BMA, as an intra-cluster MAC scheme, relative to E-TDMA depends on the sensor node traffic offer load (parameter), the data and control packet sizes, the number of sensor nodes within the cluster (parameter) and , in some cases, the number of sessions per round (parameter). BMA delivers better performance than E-TDMA for low and medium traffic loads (i.e.,) given large data packets, small control packets and few cluster nodes. E-TDMA always provides better energy performance than conventional TDMA. BMA provides lower average packet latency than E-TDMA. For very high values of, both schemes have similar average packet latencies. As goes to zero, the average packet latency in E-TDMA grows exponentially, but in BMA stays relatively low. Both energy models provide similar results when used to compare the performance of BMA against TDMA and E-TDMA. In most event-driven applications, the system parameters and the data packet size can be constrained such that BMA delivers a superior performance. For example, to keep less than 0.5 and the data packet large, sensor nodes could aggregate their sensing information from two or more events into one packet [19]. To keep the number of nodes within a cluster small, the whole network could be divided into a large number of clusters. The optimization process as described, it can be used to obtain the optimum number of clusters. Both energy models can be extended by allowing the possibility of bit-errors occurrences during contention periods.

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