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Improving the Performance of Wireless Sensor Networks: A Survey

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***Abstract*—** *Technology is growing every day and changing rapidly, the transformation of life in this technology dominated world is also faster. We have seen different technology trends in the recent past like Personal Computer, Mobile Phones, Smart Devices and the upcoming wave like IoT. In these technology trends we live in an environment filled with sensors which we use for multiple purposes like to monitor the temperature, engine performance, fuel capacity, smoke, fire alarms, security monitoring and information exchange to name a few. Wireless Sensor Networks (WSN) plays a vital role in these areas and the efficiency of the product/concept depends on the performance of WSN sensors. This paper presents literature survey to improve the performance of WSN in two aspects.*
(i). Nowadays sensor networks with WiFi communication are deployed widely .In Wifi the access point(AP) polls the nodes individually to schedule uplink transmission time results in a large latency. This paper presents MAC mechanisms in WSN communication enabled by WiFi to improve the uplink throughput of WSN in order to improve the performance of WSN.(ii).Recently cross layer operational model has been proposed to improve the performance of WSN. This paper is a literature survey on MAC mechanisms in WSN communication enabled by WiFi, cross layer operational model design for WSN to improve the performance of WSN.

Index Terms:- cross layer operational model; MAC; Wi-Fi

INTRODUCTION

Wireless sensor networks have recently emerged as a premier research topic. They have great long-term economic potential, ability to transform our lives and pose many new system-building challenges. Sensor networks pose a number of new conceptual and optimization problems such as location, deployment and tracking in that many applications rely on them for needed information. The past works are scattered across all of the systems layers: from physical layer to data link layer to network and application layer. In this report, we present an overview of wireless sensor networks and issues involved in employing them. We make an attempt to provide a snapshot of solutions proposed in recently published literature for different issues like Medium Access Control, Data Dissemination, Security and Coverage determination.

The past few decades have been significant for the development of Wireless Sensors Networks (WSN). Wireless Sensor Networks consist of spatially distributed autonomous sensors that monitor Physical or environmental conditions. In a wireless sensor networks, the lifetime of sensors is limited due to the fact that they are only self-alimented with a battery, and therefore have to use as little power as possible in order to minimize the energy consumption.

The performance of the wireless sensor networks are evaluated by the following metrics

System lifetime: lifetime is defined as the duration of time until some node depletes all its energy or duration of time until the network has been disjoined.

Energy efficiency: energy efficiency is defined as number of packets transmitted successfully using unit of energy. packet collision at MAC layer , routing overhead and packet retransmission reduces the energy efficiency.

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Reliability: reliability is defined as the ratio of successfully received packets over the total number of packets transmitted. In WSN event reliability is used as a measure to estimate the performance.

Coverage: coverage is defined as the ratio of monitored space to the entire space.

Connectivity: the connectivity metric can be used to evaluate how well the network is connected and/or how many nodes has been isolated.

MAC Techniques in WSN communication enabled by Wi-Fi:

Nowadays communication with the sensors are enabled by WiFi technology based on modification of the current IEEE 802.11 standard. A new sensor networking standard is IEEE 802.11ah is has been developed . IEEE 802.11ah is 900MHz WiFi, which is ideal for low power consumption and long range data transmission. This standard operates at 900MHz but 80% of the world uses 2.4GHz WiFi. So the IEEE is in the final phases of resolving the standard.

One of the requirement in sensor network application is need to support uplink sensor traffic with low latency. This is achieved by maximizing the uplink throughput. But sensor networks are battery powered sensor nodes so can/t support the many of the operations used in wireless broadband system. Packet retransmission is also not possible in sensor operations due to the large energy consumption. Energy efficient techniques such as collaborative transmission, efficient outer coding schemes , and sensor data fusion are suitable for sensors. but these techniques shows higher tolerance to packet losses than packet retransmission.

So, along with the physical layer enhancement , it is important to focus on how the sensor network performance channel utilization at medium access control (MAC).

One popular contention based distributed coordinated function(DCF) has been proposed. But this DCF is unfair and inefficient in terms of energy efficiency and throughput ,when hundreds of sensor nodes what to access the channel simultaneously.

To overcome the limitations of contention based DCF , Alternative contention free point co-ordination function (PCF) has been proposed . but the sequential polling mechanisms of PCF increases the waiting time for individual nodes when there is large number of lightly loaded nodes in the network , which results in loss of efficiency.

To overcome the limitations of DCF and PCF , probe and pull MAC(PPMAC) mechanism has been proposed .the basic idea of PPMAC is to parallelize the polling operation by allowing the sensor with uplink data to concurrently transmit acknowledgements to the access point (AP).this is called as parallel acknowledgement. After receiving parallel acknowledgements, the AP obtains the list of indices of nodes having data to send , then allocate the channel. To correctly detect the parallel acknowledgements at the AP, some form of signal orthogonally among the nodes is needed.

In PPMAC technique , designed a reliable non-coherent parallel acknowledgement detector and analyzed the achievable throughput of PPMAC by integrating unsaturated traffic conditions. And finally cross layer optimization framework has been proposed , which maximize the achievable throughput by optimizing the parallel acknowledgement detection statistics.

In PPMAC grouping and group scheduling is not performed. By implementing a good mechanism to group the nodes in PPMAC will improve the performance of wireless sensor network.

MOTIVATION FOR CROSS LAYER APPROACH IN WSN:-

Cross layer design is a technique of breaking of OSI hierarchical layers in communication network which can potentially be used to improve the overall performance of WSN by exploiting the interactions between various layers of the network protocol stack. In Cross Layer design the inter-dependencies between different network layers can be utilized to get statistically optimal response for different network parameters like Network lifetime, throughput, latency or energy efficiency. A cross layer interaction between the physical layer and MAC layer, network layer and MAC layer, or application layer provides further efficient use of limited network resources and improves energy efficiency. Moreover, WSN offer several avenues for opportunistic communication that cannot be exploited sufficiently in a strictly layered design. In addition, the wireless medium offers some new modes of communication as the layered architectures do not receive multiple packets at the same time. Thus, use of such “novel” modes of communication in protocol design requires violating the layered architectures. Moreover, cross layer architecture delivers the QoS reliably and flexibly to heterogeneous applications in WSN as compared to layered architectures.

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Recently cross layer operational model has been developed for mobile wireless sensor networks(MWSN).
Cross layer operational model for MWSN integrates 4 layers in the network operation.
(i).Application layer (identifies the node location)
(ii).Network layer (performs routing)
(iii).Medium access control layer(MAC)
(iv). Physical layer
Cross layer operational model for MWSN works as follows
At network initialization, the mobile node started to broadcast a neighbor discovery message to initiate neighbor(s) information collection and store it in a neighbors' list (NB-List).
After the initialization process , if a node in the network had a data to send, that data is the location information of the mobile node. The location information in the node is provided by either a GPS module attached to the node or any other methods where the nodes are able to estimate their individual locations. This node then started sending route request (RREQ) packets to establish a route to the destination node. The routing protocol in the operational model utilizes a periodic neighbor maintenance message called as hello packet. Hello packets are broadcast packets, so it can utilize the neighbor list from the network layer in data link layer. This avoids the need for neighbor discovery message to be sent by the MAC protocol. After the destination node received the RREQ packets, it replied by sending a unicast route reply (RREP) packet. The destination node embedded its own location information in the RREP message and sent it back to the next hop node in the reverse route
By using the above method the cross layer operational model leads the networks to consume while maintaining the network packet delivery ratio.
But one limitation of the above said model is more control packets especially RREQ packets which are broadcast packets. There are two ways to minimize the control packets
(i).One of the method to minimize the control packets is to implement directional broadcast flooding, which improves the channel quality.
(ii).apply clustering in cross layer operational model which ultimately improves the lifetime of a network. This paper presents a literature survey on cross layer operational model in MWSN to minimize the control packets in order to improve the channel capacity so that the performance of the wireless sensor networks is improved.
Reference [5] introduced a cross layer operation mechanism that considers the routing, MAC and physical layers to maximize the network life-time.
an energy efficient and QOS aware multipath routing has been proposed [9] for WSN. The protocol utilizes multipath routes to find the best path from source to destination. The protocol cross -layers its routing path choice criteria based the physical layer elements of the next hop. Those elements are the node(s) residual energy, interface buffer availability and the connection signal-to-noise ratio (SNR) between two neighbor nodes. The protocol is an example of the tight cross-layer of information between the physical-layer and the network layer (routing protocol).
In " lifetime extension of WSN by selecting two cluster heads and hierarchical routing " two cluster head energy efficient WSN routing has been proposed. in this method sensor nodes senses the physical parameters such as temparature, humidity, light and pressure etc and send them to base station from where one can get the physical parameters at any time. data routing methods from node to base station using two cluster heads has been implemented which prolongs the battery life of sensor node.
In "an energy efficient clustering scheme (EECS) has been proposed [8] which suits better for periodic data gathering applications. In this method cluster heads are selected with more residual energy through local radio communication while achieving well cluster head distribution.
A distributed randomized clustering algorithm has been proposed [9]. then this algorithm is extended to generate a hierarchy of cluster heads and the energy saving increases with the number of levels in the hierarchy
A load balanced clustering algorithm has been proposed in reference [6] ,performance of this algorithm is evaluated with different routing protocols. This approach balance the load among the clusters and simultaneously tries to cluster the sensor node as close to high energy cluster heads.

Cross layer detection and allocation schema has been proposed [5]to solve the hidden device problem without the cost of extra control head in data transmission. This schema detects relationships of

hidden devices based on overlapped signals and then allocates the hidden devices to distinct subperiods for transmission.

"**Throughput Enhancement of Wireless Sensor Networks with IEEE 802.15.4 MAC based on Channel Allocation**" based on IEEE 802.15.4 standard was especially designed to provide specifications for simple, low data rate, ultra low power and economical wireless personal area networks (WPANs). By exploiting the 16 non-interfering channels supported by IEEE 802.15.4, we can improve the channel capacity of wireless sensor networks. Simulation results supports improvement in throughput and reduction in average end to end delay.

CONCLUSION

In this paper we address the two scenario to improve the performance of wireless sensor networks . (i).MAC mechanisms in WSN communication enabled by WiFi has been illustrated. By grouping the nodes and scheduling the grouped nodes in PPMAC will improve the performance of WSN (ii). cross layer operational mode l has been proposed, which suffers from control packet overhead . By applying clutering in cross layer operational model will minimize the number of control packets ovehead. It is hoped that by referring the information presented in this paper, researchers will be motivated to introduce new mechanisms to improve the performance of wireless sensor network .

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