

MAC Protocols for Wireless Sensor Networks: A Survey

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ABSTRACT: Mobile Ad Hoc networks are autonomously self-organized networks without infrastructure support. Wireless sensor networks are appealing to researchers due to their wide range of application potential in areas such as target detection and tracking, environmental monitoring, industrial process monitoring, and tactical systems. Highly dynamic topology and bandwidth constraint in dense networks, brings the necessity to achieve an efficient medium access protocol subject to power constraints. Various MAC protocols with different objectives were proposed for wireless sensor networks. The aim of this paper is to outline the significance of various MAC protocols along with their merits and demerits.

KEYWORDS: NS-2; Wireless Sensor Networks; AODV; DS;, OPNET; Ad-Hoc Networks

I. INTRODUCTION

Mobile ad-hoc networks are autonomously self-organized networks without infrastructure support. Wireless media can be shared and any nodes can transmit at any point in time. In an ad-hoc wireless network, every node can possibly move and hence there is no fixed network node to act as the central controller. A MAC protocol is a set of rules or procedures to allow the efficient use of a shared medium, such as wireless. Access control protocols define rules for orderly access to the shared medium. They are need to avoid packet collisions at the receiver due to interference. Various Mac issues can be seen here are described by Chen and Sharif (2013).

1. The MAC protocol for ad-hoc networks should maximize Bandwidth efficiency.
2. Quality of service support is essential for time-critical applications.
3. Hidden and exposed terminal problems.
4. Error-Prone Shared Broadcast Channel are present in MAC protocols.

II. LITERATURE SURVEY

1. Chen et.al (2011) proposed a routing protocol cooperating with IEEE802.11 working into MAC layer called MAC layer label switch (MLLS) on demand source routing protocol based on cross layer design. They evaluated the performance of MLLS protocol comparing with DSR and AODV. They used NS-2 as the platform of simulator. They used packet delivery, control overhead and end-to-end delay as performance measure. They observed MLLS switches faster than other protocols as packet delivery ratio of MLLS is higher and control overhead is lesser than DSR and AODV.

2. The comparison of the performance of two prominent on demand reactive routing protocol for mobile adhoc network: DSR and AODV along with traditional proactive DSDV protocol is performed by Vijaya et.al (2011). They used NS-2 Simulator. Results concluded that both reactive protocols performed well in high mobility scenarios than proactive protocol.

3. Hsiang Yeh (2003) introduced the Advance Access (AA) mechanism which can solve the aforementioned interference range hidden / exposed terminal problem, additive interference problem, heterogeneous terminal problem and alternate blocking problem. He concluded AA stronger than IEEE 802.11 in terms of its differentiation capability

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for delay and throughput, effectively supporting differentiated service at the MAC layer. It can solve a variety of problems in ad hoc network and multihop WLANs. It can considerably improve radio efficiency and QoS provisioning capability in multihop network.

4. Identification of a number of unique problems in multihop network and introduction of the Interference Aware Multiple Access (IAMA) scheme for MAC in ad hoc based on detected dialogues, Triggered CTS and object to send mechanisms was proposed by Hsiang Yeh (2004). It was the first MAC scheme proposed that can solve the additive interference problem without relying on busy tone. He observed before transmission approach and variable direction, variable power declaration approach also provides an elegant solution to multichannel MAC and direction antenna.

5. X.Gong et.al (2005) proved the correctness of the proposed channel assignment protocol. Through a performance study the proposed protocol, by effectively increase capacity, substantially increase throughput and decrease delay compared to IEEE802.11 protocol. They proposed a combined proactive rating and multichannel MAC protocol that utilizes an efficient channel assignment algorithm. The proposed CA-OLSR protocol exhibit significantly lower communication, computation and storage complexity than existing channel assignment schemes.

6. A MAC protocol based on path diversity to improve the performance of ad hoc networks was proposed by lee et.al (2007). The interaction between the MAC protocol and network layers are motivated to develop a new MAC protocol and modify the existing multipath routing protocol SPAFAR. The routing protocol in network layer provides multipath information to leave the forwarding decision to the MAC layer.

7. Raymond et.al (2009) explored the denial- of- sleep attack, in which a sensor node's power supply is targeted. Attacks of this type reduce the sensor lifetime from years to days and have a devastating impact on a sensor network. They proposed a framework for defending against denial of sleep attacks and provide specific techniques that can be used against each denial of sleep vulnerability.

8. Correia et.al (2008) presented four new transmitter power control (TPC) techniques for MAC protocols in wireless sensor networks. For their evaluation four protocols has been developed: Iterative, Attenuation, AEWMA and Hybrid. They examined topics related to energy savings in the design and implementation of such protocol. They further showed TPC- technique increase the throughput due to an increase spatial reuse, as a lower transmitter power diminished the amount of back-off's before nodes send their packets.

9. The presentation of an integrated MAC and routing protocol called delay guaranteed routing and MAC for delay sensitive wireless sensor network applications was given by Shanti et.al (2008). They described the design of time slot assignment, transmission and reception cycle of nodes. They provided worst case delay analysis of DGRAM (Delayed Guaranteed Routing and MAC protocol). They concluded that as long as the inter- event time at each node is less than the maximum allowable delay, the energy consumption of network remains almost constant.

10. LU et.al (2008) presented a novel attack (the synchronization attack) on listen-sleep MAC protocol. This attack can cause 100% message loss and approximately 30% higher energy drain throughput either a cluster on the entire network. They presented a novel and powerful attack which targets the slotted protocols called the synchronization attack. They proposed a heuristically near-optimal threshold based schemes to defend against large scale synchronization attack.

11. A complete survey of the challenges and current state of the art of MANET QoS routing, signalling and MAC protocols as well as the various MANET QoS models was presented by Marwaha et.al (2008). Most of the QoS provisioning models in MANETs support integrated services type of approach because the size of MANET network and the number of reserved follows are not as large as in the wired internet.

12. Du et.al (2010) introduced a new MAC protocol EMAC (Enhanced MAC) which improves the efficiency of wireless medium reservation for general asynchronous multihop wireless networks. They observed under various

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scenarios and traffic loads that the great potential of EMAC's pioneer mechanism over RTS/CTS mechanism in improving throughput in asynchronous multihop wireless network.

13. Bhuijan et.al (2011) developed a cross layer model of IEEE 802.11 DCF (Deterministic Routing Protocols). It considers the presence of hidden stations in multihop Wireless sensor networks. They measure the performance of a multi-hop wireless sensor networks and concluded that the performance is influenced by upper layer routing protocol and measured performance of IEEE 802.11 DCF in case of specific deterministic routing protocol in the same way.

14. A novel MA-MAC (Mobility Adaptive) protocol is presented by Khan et.al (2011) in its best way. They proposed MAC provides a contention based collision free transmission by employing mechanism of allocating back off values to the joining nodes rather than random selection of values which resolves the major issue of control message collision as well. MA-MAC solves the major problem of association for mobile node by interducing the request mechanism before entering a new cluster. Results clearly showed that it outperforms the existing industrial standard of CSMA/CA as well as other mobile MAC protocols in all the performance aspects.

15. Deepalakshmi et.al (2011) introduced and evaluated a novel MAC protocol for optical networks. They proposed MAC routing protocol employs two algorithms namely the Scheming Dissimilarity in RTTs (SD RTTs) algorithm, which exploits the different RTTs (Round Trip Time) of ONUs (Optical Network Units) order to fill the gaps in scheduling program and the Minimum Delay Scheduling (MDS) algorithm, which eliminates the above mentioned gaps by prioritizing the request that cause the minimum scheduling latency. The proposed array pipeline service scheme improves the shortage of round trip time delay in conventional cyclic services.

16. The proposal of a Markov queuing model for duty- cycled nodes in wireless sensor network and using the same model to analyze the throughput, delay and energy consumption of duty- cycled MAC protocols with application to SMAC (synchronized) and X-MAC (asynchronous) was introduced by Yang et.al (2012). Markov model saves time by not requiring massive simulations to evaluate protocol performance. Results are validated by comparing with NS-2 and MATLAB simulators.

17. Evaluation of single path and multi path routing protocols over SMAC for wireless sensor networks was performed to analyze energy efficiency and routing packet overhead. Based on analysis, Ahyar et.al (2012) concluded AOMDV (Ad- hoc On -demand Multipath Distance Vector) routing protocol is better than AODV (Ad-hoc On -demand Distance Vector) routing protocol in terms of energy consumption for sending or forwarding packet data traffic, although AODMV have more packet routing overhead than AODV.

18. In order to realize large scale smart metering systems, Sugano (2013) proposed combining receiver-driven and sender-driven type MAC protocol. As a MAC protocol, the IRDT (Intermittent Receiver-Driven Transmission) method is applied which perform receiver-driven type intermittent operation. However , in the area of the around of a centre station with heavy load, since there were many nodes holding a transmitting packet, multiple SREQ (send request) packets collided to an ID packet which receiver transmitter , which results into a problem of increasing of delay or decreasing of a packet collection rate. In order to solve such a problem he proposed applying a sender -driven type MAC protocol in the heavy load area of network.

19. MAC layer misbehaviour and how they can incorporate a scheme based on MACA for wireless LANs (MACAW) and Power Aware Medium Access control with signalling (PAMAS) was studied by Diwanji et.al (2013). They emphasized on data structure used for maintaining trust and energy consumed in exchanging the trust value. The energy analysis concluded that energy consumption for transmitting a smaller data structure of trust is less and energy is consumed in transmitting the data packets and not much in transmitting and checking the trust values.

20. Akhavan et.al (2013) investigated the multi-hop performance of SB-MAC (Sender Based MAC), RB-MAC (Receiver Based MAC) and adaptive RB-MAC in RPL routing protocol. They introduced a transmission model for each protocol in a single-hop and then extended to a multi-hop mode. They studied the impact of multiple receiver

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nodes and size of preamble and different duty cycling in the protocols. Results demonstrate that in lossy channels, receiver-based protocols generate less retransmission.

III. CONCLUSION

Wireless sensor networks (WSNs) are a specified type of Ad-Hoc networks, where hundreds or thousands of low cost nodes are networked to monitor a given region. Energy consumption is one of the fundamental constraints that must be minimized in WSNs, and communication is usually the most energy-intensive operation in such networks. The survey concluded that the advance access mechanism in MAC protocol can solve the exposed terminal problem, the heterogeneous terminal problem, the interference range problem and the alternate blocking problem. IAMA (Interference aware multiple access) scheme can solve the additive interference problem relying on busy tone or dual transceivers per node. The multichannel MAC protocol is compatible with IEEE 802.11 MAC and imposes the minimum system requirement among all existing multichannel MAC protocols. The interactions between the MAC and network layers motivate to develop a new MAC protocol and modify the various existing protocols.

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