Performance Evaluation of LDCMAC for Wireless Sensor Networks

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Abstract: Wherever sensor nodes in each other's contact range (CR) exist, the data packets may be transmitted in the same loop when a wireless sensor network (WSN) occurs. On a present contentious sequential MA protocol, so few nodes can forward their data packets through multiple layers in a single loop. Consequently, there has been a notable improvement in propagation time (E2ETD) with increasing nodes. The article suggests supporting event-driven WSNs with a low-delay containment-based contending sync MAC (LDCMAC) protocol. LDCMAC doubles the level of nodes that may send their databases within the same interval while nodes has data packets in one CR. LDCMAC is assessed and its performance is compared with CL-MAC protocol using NS-3 simulations. The findings show that the LDCMAC exceeds substantially the E2ETD and packet delivery ratio of CL-MAC.

Keywords: MAC, CLMAC, LDCMAC, NS3

1. Introduction

Every position in the tracked area is within the sensor range of at least k sensor nodes within a Wireless Sensor Network (WSN). In general, the contact range of a sensor node is broader than the range of the sensor. Whenever an incident occurs, the sensor nodes M (alias k) that are within the CR of each other are also observed. Contention-based synchronous MAC protocols function on the existing cross-layer & the networking devices & sleep window (SlpW) use three windows. In DW a network application for multihop data transmission (source / original node in the expected multi-hop flow) of the data packet from the network to the final node in the expected multi-hop flow in SlpW. The DTS & the DRS (Data Receiving Section) are assigned to a node in SlpW, based on its range from the source node of the planned flow. This assumes the same DTS & DRS for different fluxes within the same DW, at the same communication range from each source node [1].

Just one sensor node could thus transfer its packets of data within a loop at least if the M sensor networks lie on one CR and try to transfer the same loop of its digital data. DTS & DRS are assigned to the node in comparative measures based on 1) when starting & receiving the data transmission request for DW; 2) the SlpW and DW (β) length ratio [2]. This means that more than 1 sensor node sends its packets of data in a circuit while a CR M sensor node attempts to transfer its data in the same chain. The transmission delay (E2ETD) has been increased in its efficiency. By using advanced
warning (EACK) and numerous flow planning functions, CL-MAC achieves its outcomes. The length of one DTS / DRS is \( \mu \) times that used for transmitting DW data conquests [3].

The levels of events (EORs) in event-driven WSNs vary over a wide span of time. In these WSNs, the sensor nodes have a low cycle potential (i.e. the smaller DW and larger SlpW cycle layout). DTS / DRS size is long sufficient to send / receive multiple packets with a high \( \alpha \) value for a limited service length. However, a sensor node is used in WSNs for compacting and/or gathering data for configured data sizes or for sending packets. Therefore, for a sensor node only a handful of data packets are expected as opposed to what a node is in its DRS. CL-MAC is faced with key weaknesses: 1) DRS is not allocated to any DW traffic source node, and 2) if the data packets of the sensor node are not scheduled to send the unused area of its one-hop neighbour DRS node. In this paper, we suggested a synchronous LDCMAC-based procedure for k-covered WSN event drive for low-delay cross-layer conflict protocols. With the following inputs LDCMAC boosts CL-MAC [4].

Each node in each flux scheduled in the DW will be allocated an interruption free DRS. Data packets from one hop neighbours that did not schedule DW can be obtained from the source node in its DRS. One source node sends its own data packagesalso receives data packagesfinished the configuration of the DW flow.

It needs a sensor Node (S j) to accept the data packet in an unexploited portion of its DRS if SJ fails to send the DW and S data request as the desired sensor node (S I reception in a single hop neighbour (S t)). S transfers data packages from S and S t to the next node in this situation. (A portion of the DRS remains left as an unused portion of the DRS of Sj after the processing of data packets from S I. These new features address two CLMAC vulnerabilities and have a wider number of sensor nodes than CL-MAC, as CR is similarly the case for M-sensor nodes with data packages. It will minimise the wait time for the data packet node queues that LDCMAC has fewer E2ETD than CL-MAC [5]. This decreases the wait time. This decreases time to wait.

2. Related work: Low Duty Cycle Mac Protocol (Asym-Mac)

One main concept in this protocol is to switch dynamically between two types: mode initiated by the sender, mode initiated by the receiver, according to the asymmetries of a relation which is determined by the PRR discrepancy between the two directions (up / down connexion). Figure1 explains the Autonomous vehicle in closed environment map. Specifically, where the connexion is asymmetric, the receiver-initiated mode is used as the default MAC protocol. Also, Figure2 demonstrates the Lane detection using OpenCv.

![Figure 1: Autonomous vehicle in closed environment map](image-url)
2.1. Design Principle

One problem is that while the sender knows when the mode is to be changed in T-mode (i.e. when there is more time off from the intended receiver to accept a sample packet), the receiver does not know when the mode is being changed. A main concept for this challenge is, at the end of each test packet transmission, to include a quick direct channel appraisal (CCA). The addition of the CCA cycle does not significantly deteriorate the energy quality provided that for a very short time, first, the CCA check lasts and second, the CCA check uses less energy in order of magnitude than the transmitting and receiving approaches. During each CCA cycle, the receiver inspects the transmitter in T-mode for possible preamble packet transmission so that data is provided to the receiver; regardless of the uplink quality. Figure 3 explains the Operation of a receiver-initiated Asym-MAC protocol.

Figure 3: Operation of a receiver-initiated Asym-MAC protocol

Figure demonstrates the depletion of MAC-initiated receptor protocols through asymmetric connexions. A test packet signified by B is routinely transmitted on the receiver. When the sender receives B, the sender continues transmitting the data denoted by DATA. However, two possible failure scenarios can occur due to the asymmetry of the relation. The 1st case (Case 1) is that B is not sent to the sender. In any case, the sender must wait for the next sampling packet, wasting time and resources in the listening state. The second case (Case 2) happens where the sender does not transfer data and the sender does not have a quality connexion (i.e. a connexion) from the sender to the recipient. Figure 4 explains the Operation of the Asym-MAC protocol.

Figure 4: Operation of the Asym-MAC protocol

It reveals how Asym MAC functions shows in Figure 5. In two modes, Asym-MAC works: R-mode and T. The MAC mode that the receiver uses is the default mode. Asym-MAC moves to T mode [7] without a sampling packet from the intended receiver.
Figure 5: A collision scenario in Asym-MAC

When a probing bundle of Receiver2 is released only after the sender's preamble has been transmitted, Receiver1, due to a collision of the Sender prelude and Receiver2 checking packet, cannot detect the prelude during the brief CCA period. CL-MAC eliminates overhead control by using different destinations for flow setting packets (FSPs).

The CL-MAC adapts animatedly to a broader variety of models and a wide variety of uniform traffic loads, boosts the distribution ratio dramatically and lowers final latency without compromise on energy efficiency. Without compromise, Multi-flow configuration is recommended in the new cross-layer multi-hop protocol. The flow configuration length is also fantastic [3].

3. CL-MAC

A synchronised MAC cross-layer contention protocol to reduce the latency in WSN propagation in a multi-hop situation. The current Loop Structure that is proposed to uses in our Protocol is to boost E2ETD besides PDR by cumulative the time for DW multi-hop flow setup relative to PRMAC, and by adding the DW data phase to DW and the SLPW validation to submit data process without increasing DW duration [4].

For heterogeneous and homogeneous WSNs, a new cycled MAC (CL-MAC) cross-cutting duty is created. CL-MAC provides a single effective flux system, allowing multiple multi-hop flows to be configured in a single loop. All flows consist of multiple packages. In addition to the routing layer information, the latest CL-MAC flow configuration functionality comes from the consideration of all buffered data packets in flow environment. CL-MAC minimises overhead control by providing multi-destination Flow Configuration Packets (FSPs). CL-MAC adapts energetically to a wide variety of traffic patterns and uniform traffic loads, increasing the distribution ratio and end-to-end latency dramatically while at the same time minimising energy consumption. In CL-MAC, flow setup packets (FSPs) are used to setup nodes. The FSP acts as the RTS package to the target node and the source node as the CTS packet. However, only FSPs have the capacity to discuss various destinations due to their special arrangement, i.e. one FSP can act as an RTS for various destinations up to K [4].

The span of an FSP depends on: at any particular node, the flow count. The location of the packet in the river, the number to give. The number of recipients to whom it delivers. The remainder of data time.

The timing of an FSP packet decides the location of the segment in sleep cycle, demonstrating how a time of the FSP decides the time of sleep in the segment in the seven destinations in FSP.

3.1. Drawbacks of CLMAC

Multi-flow configuration is proposed in the latest cross-layer protocol multi-hop. The flow configuration length is therefore very long.

a) DRS is not allocated to the root node of any DW flow, and
b) A sensor node cannot use the unused part of its one-hop neighbor node DRS to transfer datapackets if it fails to programme in the DW.
4. Proposed work: Low Delay Cross Layer MAC Protocol (LDCMAC)

A synchronous MAC (LDCMAC) protocol based on low-delay cross-layer confinement of WSNs protected by events. With the following inputs LDCMAC boosts the CL-MAC:

It provides respectively node of each flow scheduled in the DW with an interruption free DRS. Data packets of a one-hop neighbors that have failed to schedule in DW can be obtained in their DRS by a source node. A source node sends its own data packets via flow setup in the DW [1] and received data packets.

It allows a $S_j$ node to accept a single-hop nearby ($S_t$) data packet in the non-used portion of their DRS if the DW and $S_j$ request takes requests for data transfer from the sensor node ($S_i$) to the next-hop receiving node in the same DW scheduling by $S_t$-forward.

These revolutionary features remove the two CLMAC vulnerabilities listed and permit extra sensor nodes than CL-MAC, when $M$ sensor nodes and data packets are in the CR of each other in the same cycle. This lowers the waiting time for sensor queues of data packets [5].

4.1. Data Packet Transmission Flow Setup Process In DW

At the start of the DW, a DIFS+rand(CW)$T$ slot tracker can be transmitted to each packets of data sensor node & sensed as a medium. This node transfers the message towards the next hop receiver node if it could not proceed to be notified until the time expires. The FSP control packet (Flow Set-up Package), contains the transmitter, next-hop recipient, predecessor & final destination, sends a data transfer order (here, Rand (CW) also $T$ slot reflect the chosen randomly containing window (CW) & one CW slot length respectively). A node receiving FSP as the destination of the next hop recipient forwards the FSP request to its newest hop request if its destination does not end at all and the remainder of the DW period is appropriate for FSP to be transmitted. The transmission of its packets of data to its DW over many hops is thus an expected node. In SlpW, if it is in a flow designed for DW in the same loop, the primary transmitter (PS) node [6] is referred to.

In the SlpW though, the node is considered the secondary transmitter (SS) node whether it has the data paquets to transmit & not apart of a flow that is set in the DW of the same cycle. LDCMAC’s distinctive aspect is that, in contrast to existing protocols, it requests that an SS node send its packets of data to the DRS of its PS one-hop next door node. This feature is the best LDCMAC performance than existing protocols [7].

After FSP has been overheard, an Algorithm 1 SS node is used to pick a suitable next-hop recipient node and to identify the DRS of the node. Algorithm 1, assuming in DW S is, Si to Sj is not planned & in the same DW the FSP transfers Si to Sj. S choose Si as its next hop beneficiary only when $S_j$ does isn’t in its CR in this algorithm. That’s because the hop difference is lower than the difference between $S_j$ & Si. The DRS of $S_i$ depends on whether Si is the root node or not [8].

4.2. Dts/Drs Determination In SlpW0

The beginning of its $\mu$ TFSP length DTS is specified by a PS node ($S_j$) after sending the FSP

$$DATA_S = t + \gamma(t^{FSP}(S)) - 4.1$$

$$t_{TX} j S_{lp} W TX DW i$$

In the event that $S_i$ is a source node, the start of its DIFS length DRS is calculated as

$$DATA_S = t + \gamma(t^{FSP}(S)) - DIFS - t - 4.2$$

$$t_{RX} i S_{lp} W SlpW i DW$$

If $S_t$ is then known as the main node,

$$DATA_S = t + \gamma(t^{FSP}(S)) - SIFS - t - 4.3$$

$$t_{TX} W S_{lp} T x FS i DW$$

In addition, the recipient node ($S$) decides the beginning of its $\mu$ TFSP length as on FSP receipt as a destination receiver.
\[
\text{DATA}(S) = t_{Rx} + \gamma (t_{FS}(S)) - t_{SlpW}^{Rx_{j}} - 4.4
\]
The time at which a node begins to transmit/receive data transfer request in DW b) \( \alpha \) (the ratio of the durations of the SlpW and of the DW) is defined for DTS/DRS in LDCMAC.

4.3. Algorithm
The algorithm is used to choose a suitable recipient node and to decide the DRS of the node [9]. The method is defined in algorithm 1, given that Stfailed to schedule the DW and overheard the FSP sending the same DW by Sito S jin. Stchooses its next-hop recipient only if S Jdoes not collapse within its CR within this algorithm. This is because the hop gap between S j and S is smaller than Si [10].

4.4. Structure of Algorithm

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{algorithm.png}
\caption{Algorithm}
\end{figure}

\begin{algorithm}
\begin{algorithmic}
\If{\( S_j \) is one-hop neighbour of \( S_t \)}
\State \( DATA(S) = t + \gamma (t_{FSP(S)}) - t_{Tx} \)
\State \( S_{slp} \) \hspace{1cm} \( T_x \) \hspace{1cm} DW
\State \( j \)
\ElseIf{\( S_i \) is source node}
\State \( DATA(S) = t + \gamma (t_{FSP(S)}) - DIFS - t_{Tx} \)
\State \( S_{slp} \) \hspace{1cm} \( T_x \) \hspace{1cm} DW
\State \( i \)
\Else
\State \( DATA(S) = t + \gamma (t_{FSP(S)}) - SIFS - t_{Rx} \)
\State \( S_{slp} \) \hspace{1cm} \( T_x \) \hspace{1cm} FS
\State \( i \)
\EndIf
\end{algorithmic}
\end{algorithm}
The SS node & PS node for transferring the packets. Figure 6 explains the Algorithm.

The RTS / CTS handshakes with their next hop receptor node are followed by a PS node at the start of their DTS and send data packets afterwards. A RTS (Request to Transfer) packet includes the sender's and receiver's addresses, and the sender's time to send the data packets. A CTS packet includes sender and recipient addresses and the time taken in RTS to transfer data. Data is transmitted by the CTS packet.

But at the other hand, the SS node at the opening of the chosen DRS receiver node will set a time limit for the rand (CW)T slot duration. If RTS / CTS is obtained before the period of expiration, an SS node cancels its timer & sleeps the amount of time it provides. The medium for rand (CW)T slot length is awakened & established. Should the correspondence between SS nodes not continue until the end of their word, they report the handshake RTS / CTS & send their packets of data with their selected receiving station. (Please be aware that rand (CW) T slot is helpful in preventing collisions in between SS nodes) [11].

4.5. Data Packet Transmission Flow Setup in DW
Accept that the data transmission contention is won by the node of St (see Figure. 1) & its FSP transfers to Si node. Si is not the last location; FSP will be sent to the next (S) location. Follow Stand Si PS nodes (1) after submitting FSP, to decide the start of the \( \mu \) TFSP DTS length. On reception of the FSP, Si and S is accompanied by (3) to decide the start of their TFSP DRS length \( \beta \). The St follows (2) root node to define the commencement of DRS \( \alpha \)-DIFS time. In the photo. 1, it should be remembered that the PS node DTS overlaps its expected next-hop node receiver with the DRS [12].

Sjlos the channel entry container to Stand overhears the FSP sent via the StandSi sensor nodes. The SS node Sj selects Si as its next recipient according to Algorithm 1, which decides Si DRS [13]. The SS node Si is based on obtained FSPs. Figure 7 explains the Data transmission process.

4.6. Data Transmission InSlpw
The Root node "S t" boots up at the start of its DRS to receive packets of data from an SS node. Even then, this might happen if no SS is available to transfer data packets. After \( \mu \) seconds where \( \mu = CW.T + T \) DATA will sleep the receiver node from the start of its DRS [14].

At the start of S I\'s DRS, the SS Node Sj established a timer for the Rand (CW) T cycle & described the median, while the PS Node S t began S I with a hand shock for the CTS / RTS. S t sends the data packet to S I just after handshake RTS / CTS. The S j node stopped while the RTS submit was intercepted by S to S I & slept so that the chain of the data transfer did not overhear & listen idle. It awakes & sets up a timer for the rand (CW) T. At the end of the timer, SI will obey the handshake RTS / CTS & send the dataset. A receiver\'s node sleeps if a packet RTS / DATA doesn\'t appear to be transmitted \( \mu \) seconds after the last ACK. PS Node S After the RTS / CTS handshake I transmit all its frames to S in DRS of S. In one loop S is then retrieved from the packets received of both nodes. In comparison, for this purpose two cycles (one cycle for each S and Sj) will be sufficient in each of the other existing contention-based synchronous protocols across cross-layers.
4.7. Network Model
Consider a $k$-covered network with a randomly deployed uniform tracking of events in the $A_sB$ region ($S_1, S_2, \ldots, S_n$) sensor nodes. The clusters of $M$ ($k$ is $M < n$) sensors ($S_1, S_2, \ldots, S_m$) lying in each other’s CR are observed on this network. In the controlled area the sink node ($S$) is located. There are stationary both sensor nodes and sink node. Support $S_t = S_1, S_j, S_2, S_i = S_3$ [15].

5. Results And Discussion
Figure 8 explains the screenshot shows the simulation of packets. Node 0 represents source node and transmits packets and node 1 represents secondary node also transmits packets simultaneously to sink node. However, node 0 and node 1 does not send their packets to each other. Node 2 represents sink node that receives the packets from the node1 and node0 and sends acknowledgement to both of the nodes simultaneously. The packet distribution ratio is indicated by the number of packets obtained by the sink node. Less time would increase the delivery ratio of the packet.

![Figure 8: Screenshot of the visualization window](image1)

![Figure 9: Screenshot of the terminal](image2)

Figure 9 shows the screenshot of the output after all the packets transmitted in the visualization window. Once the simulation is done throughput displays in the terminal. The obtained throughput is 54%. To increase the throughput, distance between the nodes should be larger which leads to energy consumption.
Theoretical calculations
Duration of synchronization window=55.2×10^{-3} sec
Scheduling window=100×10^{-3} sec
Sleep window=14.844 sec
DIFS=50 µsec
SIFS=10 µsec
FSP=12 bytes/sec=96 bits/sec
From equation 4.1
\[ \text{DATA}(S) = 14.25 \times 10^3 \text{ sec} \]
\[ t_{TX} \]
From equation 4.2
\[ \text{DATA}(S) = 14.38 \times 10^3 \text{ sec} \]
\[ t_{RX} \]
From equation 4.3
\[ \text{DATA}(S) = 14.25 \times 10^3 \text{ sec} \]
\[ t_{TX} \]
PDR=
\[ \frac{\text{Total no. of packets successfully received at the sink}}{\text{Total no. of packets generated at the source during simulation time}} \]
\\=56\%
The above value gives the simulation time to transfer and receive all the data packets. Primary and secondary nodes take same time to transfer the packets.

6. Conclusion
LDPCM allocates DRS to a node which either collect or transmit the FSP as the next hop receiving station in its DW. It will send to the node that failed in the flow setup of DW’s data packet pass a section of your one-hop neighbour’s DRS data packet. These factors expand the amount of knots which the data packet can be transmitted in a single loop if the CR each contains multiple knots which transmits packets of data. As a result, E2ETD & PDR are far better than existing sync Cross-Cutting MAC protocols.

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