MINIMUM LENGTH MINIMUM DELAY SCHEDULING USING ARTIFICIAL BUTTERFLY OPTIMIZATION (ABO) ALGORITHM IN MANET

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ABSTRACT: Recently, the requirement for various real-time applications over Mobile ad-hoc networks (MANETs) has been increasing tremendously. Packet scheduling and routing algorithms are the important factors for improving the Quality of Service (QoS) parameters over the MANETs. Still, it is not easy to proficiently aid multimedia broadcast with its stringent delay constraints over MANETs. Moreover, there are several problems in assisting QoS over MANETs owing to interference amid nodes in the network. In this paper, Minimum Length Minimum Delay Scheduling (MLMDS) using Artificial Butterfly Optimization (ABO) algorithm is proposed. A fitness function for ABO is derived in terms of the round trip scheduling delay, the conflict graph and the amount of slots in the data sub-frame. A slot selection algorithm is proposed such that the selected slot is supposed to yield lesser delay and spatial reuse. By simulation results, it has been shown that MLMDS achieves minimum delay with higher throughput.

Keywords: Mobile ad-hoc network (MANET); Scheduling; Slots; End-to-End Delay; Throughput; Artificial Butterfly Optimization (ABO).

1. INTRODUCTION

MANETs are trivial networks that function deprived of utilization of any vital alerting and monitoring device. Each device in mobile ad hoc network has the ability of getting, transferring, in addition to progressing. MANETs have a flexibility restraint as an obstacle to their act. Usually, MANETs are utilised for certain serious circumstances like calamity managing, airplane damage enervation system, enemy tracingscheme[1]. Quality of Service (QoS) is an important aspect of MANET. It is a group of operator defined assurances like extreme bandwidth, least delay, least jitter and least packet loss level to be guaranteed by the network[2]. Recently, the request for several multimedia applications on request amenity over MANETs has been mounting fast. On the other hand, it is not easy to aid the data broadcast inside the endwise delay necessities over MANETs. The packet scheduling and routing procedures are the significant aspects for enlightening the QoS factors over the MANETs [3].

For broadcast of non-concurrent data, scheduling is not a serious problem, the data is flexible. But at all times it has high necessity for packet loss. For actual broadcasts like video conference, the major pre requisite is to transfer packets to the terminus prompt. People cannot endure huge interruption. As a consequence, certain QoS mechanisms are desirable to make sure the essential superiority of the association for actual broadcasts[4]. There are several problems in helping QoS over MANETs because of interference amongst nodes, time-changing network topology and set aside battery power[5][6].
In this paper, Minimum Length Minimum Delay Scheduling (MLMDS) using Artificial Butterfly Optimization (ABO) algorithm is proposed.

2. RELATED WORKS
Samuel Kakuba et al [7] have suggested an enriched LLQ procedure which stays voice packages that attain while the real-time packages are previously in the buffer. It services video packages identified in the buffer in advance to servicing voice packages providing, the voice packages are not postponed outside the extreme bearable delay boundary. Naresh Vattikuri et al [8] have suggested a delay subtle method to slot consignment issue in dispersed AWNs. The suggested method does a harmonizing performance amid endwise delay and spatial reprocess. The investigational outcomes validate that the suggested method gets eminent outcomes regarding call receipt rate, endwise delay and spatial reusability. Petar Djukic et al [9] have offered a technique that discovers interference-free TDMA plans with least scheduling latency. They presented that the latency can be inferred as a cost, regarding broadcast order of the links, poised over a series in the interference chart.

Lakshmi et al [10] have suggested Selfish Scheduler Queue Methodology (SSQM) that can effectually and proficiently offer a responsive resolution that could manage the queues through which the packages are promoted from the base to the terminus through the self-centred nodules. Aghigh Rahdar et al [11] have suggested a model for time-slot distribution in WANET. Then, the core principles, power depletion and delay are articulated subsequently to allocate more suitable slots to the nodes.

3. PROPOSED SOLUTION
In this paper, Minimum Length Minimum Delay Scheduling (MLMDS) using ABO algorithm is proposed. A fitness function for ABO is derived in terms of the round trip scheduling delay. The conflict graph (Gc) and the No. of slots in the data sub-frame (Nd). A slot selection algorithm is proposed such that the time selected by a node is predictable to produce lesser delay and spatial reuse.

3.1 Minimum Length TDMA Scheduling
To find a least number of periods essential to schedule all links, $N_{\text{min}}$, scale down the link rates with

$$\alpha = \frac{N_j}{\max(N_{\text{min}}, N_j)} \quad (1)$$

In order that it suits a static mount with Nd data periods. Deprived of the scaling, this procedure discovers the least sized TDMA plan reliable to the earlier literature in TDMA programming. Reducing the link rates has the identical result as augmenting the border dimension, deprived of the effect on postponement or applicability of the procedure to TDMA MAC etiquettes with stable border lengths like 802.16 and 802.11s.

3.2 Scheduling Delay (Di)
We discover the endwise Di for a track $P_t$ by discovering the delay experienced during navigation of the equivalent cycle $D_t$ in the interference chart:

$$D_i = \sum_{c_j \in \theta_t} (s_j - s_i + o_j T_j) - \sum_{c_i \in \theta_t} (s_i - s_j + o_j T_j - T_j) \quad (2)$$

Where $c_j \in \theta_t$ are the interferences navigated in their route and $c_i \in \theta_t$ are the interferences navigated in their reverse route. The Di estimation can be modified based on the transmission order as

$$D_i = \sum_{c_j \in \theta_t} o_j T_j - \sum_{c_i \in \theta_t} (1-o_j) T_j \quad (3)$$
3.3 Fitness Function
The fitness function is derived in terms of the $D_l$, the $G_c(E,C)$ and $N_d$ as defined by.

$$\text{Fitness}(i) = F(G_c, N_d, D_l)$$  \hspace{1cm} (4)

3.4 Artificial Butterfly Optimization (ABO) algorithm
Regarding high dimensioned search space, prevailing stochastic optimization procedures like ABC, PSO and GA have a meagre merging actions. ABO procedure does well in harmonizing two main procedures: examination and manipulation. Manipulation aims to hunt prudently and meet to the best while examination does a procedure to escape from the indigenous optimum. It is depended on the mate-finding approach of certain butterfly types. Two sets of artificial butterflies are hired for faking the flight plans: The sunspot butterflies (SB) and Canopy butterflies (CB)[12].

In this stage, we utilise ABO procedure to discover the minimum length minimum delay schedule (MLMDS). Butterfly territoriality bids an outstanding model scheme for precise examination into how life history optimization disturbs lifespan speculation in violent performance. Spotted woods also provide a magnificent motivation for suggesting a novel optimization procedure.

The unique butterfly populace was split into two sets by their ability. Diverse flight approach is used for every set. There exists 3 flight modes together with sunspot flight (SF) mode, canopy flight (CF) mode and free flight (FF) mode. These manners can be provided diverse flight approaches. ABO can make a novel procedure when any one of three flight manners is provided a novel flight approach.

4. The pseudocode of ABO algorithm is listed below

**Pseudo code of ABO algorithm.**
1. Prepare the positions of butterfly populace
2. Assess the suitability of each butterfly
3. while(not see the fatal circumstance)
4. Class entire butterflies based on their suitability
   5. if (suitability$>$ FT), then
      6.   Make SB ,
   else
      7.   Make CB
   end if
6. for (every SB)
   7.   Hover to one novel position based on SF manner
   8.   Assess the suitability of the novel sunspot
   9.   Use covetous choice on the unique situation and the novel one
   end for
7. for (every CB)
   8.   Hover to one arbitrarily designated SB based on CF manner
   9.   Assess the suitability
   10. if(suitability$>$ FT)
       11.   Use covetous choice on the novel position and the novel one
    else
       12.   Hover to novel position based on FF manner
    end if
7. end for
11. end while

4.1 Mate-finding strategy
Certain constraints are formed to enhance the mate-finding plans of butterflies:
(a) So as to augment the chances of meeting females, the whole each males effort to hover towards a fine place termed as sunspot.
(b) To inhabit a fine sunspot, every SB always efforts to hover to its neighbour’s sunspot.
(c) Every CB repeatedly hovers towards any SB to resist for the sunspot. A D-d vector is utilised to signify the position of a simulated butterfly.

4.2 Flight Strategies of Butterflies
1) Every butterfly hovers towards an arbitrarily chosen neighbour succeeding Eq. (4). This approach is utilised for the SF mode or the CF mode.

\[ X_{i,j}^{t+1} = X_{i,j}^t + (X_{j,k}^t - X_{i,j}^t) \cdot \text{rand}(\) \]

Where \( i \) is the \( i^{th} \) butterfly, \( j \) is an arbitrarily chosen measurement value amid \([1,D]\), \( t \) is the no.of reiterations and \( k \) is an arbitrarily chosen butterfly, which is not similar to \( i \).

2) Every butterfly hovers in the direction of an arbitrarily chosen neighbour one succeeding Eq. (5). This approach is utilised for the SF mode or the CF mode.

\[ X_{i,j}^{t+1} = X_{i,j}^t + \frac{X_{j,k}^t - X_{i,j}^t}{\|X_{j,k}^t - X_{i,j}^t\|} (U_{b} - L_{b}) \cdot \text{step} \cdot \text{rand}(\) \]

Here \( i \) denotes the fake butterfly, \( t \) denotes the no.of reiterations, step is the novel position of the \( i^{th} \) simulated butterfly, \( U_{b} \) and \( L_{b} \) denote the smaller and greater bounds of the flying order for the \( i^{th} \) simulated butterfly, respectively.

The parameter step in Eq. (5) can be given by

\[ \text{step} = 1 - (1 - \text{step}) \cdot \frac{E}{\text{max} \cdot E} \]

Where \( E \) is present assessments sum and \( \text{max} \cdot E \) is the maximum assessments sum.

3) Every butterfly hovers towards an arbitrarily chosen neighbour succeeding Eq. (7). The identical method has been used to hunt for a novel location in the investigation stage. This approach is utilised for the FF mode in ABO procedure.

\[ X_{i,j}^{t+1} = X_{i,j}^t - 2.\text{a.rand}(\) - a.D \]

\( i \) denotes the \( i^{th} \) simulated butterfly, \( X_{i,j}^{t+1} \) denotes the novel position of the \( i^{th} \) simulated butterfly, \( a \) is linearly lessened from 2 to 0 during reiteration, \( D \) denotes an arbitrarily created value succeeding Eq. (7).

\[ D = |2.\text{rand}.X_{i,j}^t - X_{i,j}^t| \]

4.3 Slot Selection Algorithm
The timeselected by the node is estimated to offer less endwise interruption while being sensible about spatial reprocess additionally. If endwise interruption for a provided flow is to be within $D_{max}$, it infers that accrued interruption at every node must not surpass the same. Our procedure limits every node to choose a period so that it doesn’t rupture $D_{max}$, $N$ is the no. of flights in the flow.

**Algorithm-2: Slot Selection**

1. In the procedure of choosing a period for a node, it sets the idle periods in two-hop adjacent into 2 groups: spatially returnable ($S_{sp}$) and spatially non-returnable periods ($S_{other}$).
2. $S_{sp}$ is the connection of the group of present free slots ($S_{free}$) on node $N_i$ and group of periods utilised by other nodes earlier to $N_i$ in the present flow ($S_{sp}$).
3. $S_{other}$ will comprise the enduring periods in $S_{free}$ which are absent in $S_{sp}$.
4. For every period in $S_{sp}$, an interruption ($\Delta_i$) is intended which will be the interruption experienced on this node if the period is selected.
5. Fundamentally this latency is the time variance amid P (period utilised by the antecedent node) and the period in $S_{sp}$ set.
6. After the latency for the entire periods in $S_{sp}$ is intended, find a period which offered least interruption ($S_{spMin}$) and the conforming interruption as $\Delta_{spMin}$.
7. If this period is persuading an interruption below D, then this period will be designated and the procedure finishes
8. else
9. Transfer to fix $S_{other}$ and reprise the procedure to discover the period in $S_{other}$ which will provide least interruption amid the entire periods in $S_{other}$ ($S_{min}$) and conforming interruption as $\Delta_{other}$.
10. If $\Delta_{other} > \Delta_{spMin}$ Then
11. Choose the period $S_{min}$ (the idle period providing least probable interruption on this node)
12. Else
13. Select $S_{spMin}$ (the idle period providing least probable interruption)
5. RESULTS & DISCUSSION

5.1 Experimental Parameters

The proposed MLMDS algorithm is implemented in NS2 and is compared with the delay sensitive TDMA (DSTDMA) [8] slot assignment technique. The experimental parameters are exposed in Table 1.

Table 1: Experimental parameters

| Parameter                  | Value                  |
|----------------------------|------------------------|
| Number of nodes            | 100                    |
| Size of the Topology       | 1300 X 1300m           |
| Data sending Rate          | 100 to Kb/s.           |
| Traffic type               | Constant Bit Rate      |
| Propagation model          | TwoRayGround           |
| Antenna type               | Directional Antenna    |
| Assigned energy            | 13 Joules              |
| Transmit Power             | 0.660 watts            |
| Reception Power            | 0.395 watts            |
| Idle Power                 | 0.35 watts             |

A. Based on Data Flows

In this section, the number of data flows is varied from 2 to 10.

Figure 1: End-to-End Delay (Flows case)

Figure 2: PDR (Flows case)

Figure 1 and Figure 2 shows the latency and packet delivery ratio (PDR) results, respectively, for the Flows case. The figures show that delay and PDR of MLMDS is 68% lesser and 24% higher, when compared to DSTDMA.
Figure 3: Throughput (Flows case)  
Figure 4: Residual Energy (Flows case)

Figure 3 and Figure 4 shows the throughput and average residual energy obtained, respectively, for the Flows case. The figures show that throughput and residual energy of MLMDS is 89% higher and 36% higher, when compared to DSTDMA.

B. Based on Data sending Rate

In this section, the data sending rate is varied from 100 to 500Kbps.

Figure 5: End-to-End Delay (Rate case)  
Figure 6: PDR (Rate case)

Figure 1 and Figure 2 shows the latency and PDR results, respectively, for the rate case. The figures show that delay and PDR of MLMDS is 35% lesser and 80% higher, when compared to DSTDMA.
Figure 7 and Figure 8 shows the throughput and average residual energy obtained, respectively, for the rate case. The figures show that throughput and residual energy of MLMDS is 67% higher and 19% higher, when compared to DSTDMA.

6. CONCLUSION
In this paper, Minimum Length Minimum Delay Scheduling (MLMDS) using Artificial Butterfly Optimization (ABO) algorithm is proposed. A fitness function for ABO is derived in terms of the round trip scheduling delay, the conflict graph and the number of slots. A slot selection algorithm is proposed so that selected slot is expected to yield lesser delay and spatial reuse. The proposed MLMDS algorithm is implemented in NS2 and is compared with the delay sensitive TDMA (DSTDMA) slot assignment technique. By simulation results, it has been shown that MLMDS achieves minimum delay with higher throughput.

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