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Congestion Avoidance Using Enhanced Blue Algorithm

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Abstract

This paper addresses congestion avoidance using enhanced blue algorithm (EBA) for data transferring in a network. The congestion of data always affects the data transmission on the internet for various applications. For developing data transmission performance, the congestion of data is a challenging task. Although, different approaches have been used to avoid data congestion, yet we have considered a data transmission framework for better performance compare to existing approaches. Thus, we considered the advanced Blue Algorithm which is used to determine the node's capacity with middle path and it prevents congestion by monitoring of data during data transmission. The role of gateway is considered to supervise status of congestion for both data sending and receiving based on positive or negative acknowledgment as well as data size. The gateway is also used for a congestion notification system to alleviate congestion and enhance throughput. During experimental analysis, we have taken comparative performance between existing and our proposed model. For example, in Enhanced Ad hoc On-demand Distance Vector (EAODV), during the packet size of 10, the average end-to-end delay is 32.63 ms whereas in proposed advanced Blue algorithm, the average delay is only 19.11 ms. Thus, the proposed model using Blue algorithm is performed better than existing method.

Keywords Packets · Throughput · Threshold value · Compressed data · Congestion control

1 Introduction

The huge amount of data has been used by internet as per user demand for various applications. The network technologies have been also developed to fulfil user demand. But more use of data from internet creates a problem for transferring data due to congestion during data transmission. Generally, Congestion happens due to lack of accommodation for all arriving packets in internet. Different approaches have also developed to control congestion of data

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like Adaptive Gentle Adaptive Random Early Detection (AGARED) method and Adaptive Random Early Detection (ARED) [1]. AGARED method is very much exciting approach to perceive the congestion at early stage when the router buffer overflows. These approaches are used the parameter setting based on optimal threshold value for various situations. So, it controls the congestion during data transmission. They didn't use congestion avoidance approach for data transmission.

The endpoint congestion is vital for latency -sensitive applications. For long message, longer time is required than round trip time (RTT) which creates endpoint solution. For hybrid message, traffic is dominated by short messages. Thus, the traditional congestion avoidance approaches found the challenging task for dynamically changing of short messages. Although, the few approaches of congestion avoidance have been developed during data transmission, still, it needs to improve the performance to avoid congestion. Thus, we have proposed the enhanced Blue algorithm for managing congestion issues. This approach is determined the capacity of the node for finding the middle path.

We considered queue management system which can effectively lower packet loss rates on the Internet, while the present solutions are unsuccessful at preventing high loss rates. This system is also determined the length of queue for measuring of bad congestion. In light of this fact, the BLUE active queue management algorithm is suggested to control congestion and makes use of packet loss and link idle events. The EBA is demonstrated in terms of packet loss rates and needed buffer sizes using both simulation and controlled the testing. To prevent dropping of packets or congestion, there are several queue management techniques are considered in our proposed framework such as passive queue management and active queue management. When the queue overflows, passive queue management drops merely the packets (e.g. Drop Tail) but the active queue management (e.g. other name is random early detection (RED)) manages the queue and controls the dropping packets through dropping probability procedure. The main difficulties are defined in problem statements as Sect. 3.

The major contribution of our proposed model is as follows.

(a) We designed active queue management (for random early detection (RED)) which helps to identify congestion through dropping packets.
(b) We developed enhanced blue algorithm for drop probability for frequently dropped packets.
(c) Our model helps to identify forwarding data size and compressed data.
(d) We have considered 50 nodes for simulation and use breadth first search techniques for effective result.
(e) We also considered comparative performance with existing results.

The remaining sections are arranged as follows. Section 2 is considered for related work or background of the proposed model with various analysis like theoretical and result analysis. The problem statements is explained in Sect. 3. The queue management system is explained in Sect. 4. The analysis of enhanced blue algorithm is developed for congestion avoidance in Sect. 5. The simulation and comparative analysis are described in Sect. 6. The whole paper is concluded in Sect. 7.

2 Literature Survey

In this section, we have explained different existing approaches to know the theoretical and experimental information related to the proposed model. Different authors also developed various methods as generic or specific model in network system which are explained as follows.

Yifei Lu et al. [2] explained an algorithm for controlling TCP congestion in data centre networks. The threshold of Explicit Congestion Notification (ECN) must not be deployed inappropriately, because it may lead to a bottleneck in the networks. DEMT algorithm is used to control the flow of the network. These algorithms improve the performance, throughput, delay and queue length which is used to define the effectiveness of the algorithm. Deadline awareness protocols was integrated with DCTCP to provide excellent performance. Wei Wang et al. [3] suggested an algorithm for multipath TCP, which controls congestion and all based on the effectiveness of energy in a 26 heterogeneous network. The author focuses on throughput and energy consumption of the network, especially at the receiver side. However, the transmission rate has not been controlled, and the performance rate can also be increased. Atilla EryÕlmaz & Srikant [4] depicted an algorithm for resource allocation as per size of the queue. Above method made the buffer levels, using virtual queues. Furthermore, the Flow rate can be detected using the virtual queues and hence it is possible to increase the rate of transmission. Srinivas Rao & Sudhistna Kumar [5] suggested a congestion control protocol (CCP) for multitasking approaches. The author discussed three phases such as receivers with high energy, queue size of the output multicast traffic rate Energy efficient and reliable congestion control (EERCC) in decentralized manner. Gaurav Sharma et al. [6] discussed the guaranteed throughput with distributed scheduling in wireless networks. This mechanism was even tested under SNR phase, where synchronization was imperfect. Gaurav Bansal et a. [7] suggested an algorithm for DSRC Congestion control. This mainly focuses on the vehicle infrastructure such as the location, speed rate, and traffic rate. This paper suggested the use of congestion control algorithms in the vehicular environment. Hence, effective channel utilization can be achieved. However, high-density scenarios have not been taken care.

Kefan Xiao et al. [8] suggested a congestion control scheme for radio networks which includes the robust future of networks. Stabilizing the queue at the TCP layer helps in maintaining the time-varying capacity of the nodes. Secondary users were mainly benefitted using this scheme for congestion control related threats in radio networks. Vishnu Kumar Sharma & Sarita Singh Bhadauria [9] proposed a protocol for congestion control based on mobile agents. Packets loss was the main issue in congestion control networks. To resolve this, mobile-based agents are used in networks. Mobile agents (MA) collect the necessary information about network congestion, and they are distributed among the networks. Status of the nodes can be identified using this protocol and hence supports reduced delay when in comparison with the prior techniques. Poonam Verma et al. [10] developed CCP for vehicular networks. They are assigned at the MAC layer, with back –off random process. This enhances the performances of the algorithm ranging from saturated to no saturated networks. The author proved that the algorithm works better even under high vehicle density. Oussama Habachi et al. [11] proposed a congestion control algorithm for traditional services in WN based on MOS. The author expressed MOS (Mean Opinion Score) based congestion control estimates the optimal policy, especially for multimedia services. The author concluded that improved Additive Increases Multiplicative Decrease (AIMD) mechanisms for congestion control are possible by testing on both unidirectional and bi-directional scenarios. Yue Zhao et. al [12] took a stochastic method which was used to evaluate each flow of data. On the other hand, real-world networks have random flows, are limited in number and leave once data transfer has been completed. Akbar Pandu Segara et al. [13] proposed the technique presents a route discovery methodology for finding the optimum packet forwarding paths. Because it can take advantage of the earlier Dijkstra and Bellman-Ford algorithms, the approach investigates Johnson's algorithm. L. Hernandez et al. [14] Experimenting with IPv4 and IPv6, monitoring metrics like Jitter, Delay, and Throughput, are performed with help of physical network architecture. Repeating the process and testing using SDN in network architecture with comparable characteristics were discussed. Sergi Rene et. al [15] suggested method makes use of storage that is located within the network. Because they operate as custodians for the data they have received, intermediate routers and caches are not permitted to drop any data that they have received. Balint K.Vari et al. [16] analyzed their performance based on traditional metrics such as the average amount of waiting time, the average amount of time spent travelling, and sustainability metrics such as carbon dioxide emissions and fuel usage. Quoc-Viet Pham & Won-Joo Hwang [17] surveyed a maximal utilization of networks, which are based on congestion control. Maximal networks utilization lies in the usage of resources allocation. Congestion control along with traffic rates in the network can be mutually controlled using cross-layer design which helps in controlling congestion and improve the performance of Network Utility Maximization (NUM) based on system networks. Yufang Xi & Edmund M Yeh [18] suggested an optimal congestion control and routing based mechanism for nodes in the networks to be maintained in an integrated order where a physical layer structure is used. This helps in minimizing the convex links costs as well as delay due to queues. Bhuyan et al. [19, 20] developed multiparty computational approaches for both centralized and decentralized network. They have considered the model for data transferring from one level to another.

Distributed networks help in presenting node by node analysis of congestion control, power control and routing-based networks. The author concludes that these schemes and mechanisms can be used to optimize the user input rates. Li Yuzhou & Shi Yan [21] suggested end-to-end and allocation-based congestion control algorithms in Wideband Code Division Multiple Access (WCDMA) networks. The problems were based on Network Utility Maximization and Radio Access Networks (RAN). A solution is triggered for those problems, which includes the increase in end-to-end throughput of the WCDMA networks. Kai Shi et al. [22] proposed a congestion control concept for lossy wireless networks, and it is based on receivers in the networks. Here receiver computes the bandwidth and allocates the window size to the sender. The sender uses Additive Increase and Multiplicative Decrease (AIMD), and by combining loss and delay-based traffic control, losses can be rectified. This alleviates the effects of the timeout and increases bandwidth. A. Vijayaraj et. al [23] proposed that a technique based on notoriety could be used to improve the adaptability of a deterministic distributed hash table (Halo) that is neighboring a toxic hub. The data that has been partitioned off from failing hubs can be used collaboratively in order to circumvent the action of malignant hubs in the system.

Yunliang Liao et al.[24] proposed the TSBA method is recommended, which uses a two-way handshake method to encourage transmitting and receiving nodes to collaborate so that subsequent interactions run smoothly. When solving isolated nodes, the TSBA approach, on the other hand, caused conflict and interference among nodes. Omar Ahmed et al. [25] discussed the method tackles critical issues in WBAN routing, such as energy efficiency, congestion-free communication, and decreasing negative thermal impacts. The congestion avoidance approach is combined with energy efficiency, connection dependability, and route loss to simulate the cost function that the EMSMO uses to determine the best routing. Fan Qiu & Yuan Xue [26] proposed scheduling mechanism for multi-hop networks with feedback delay. They are mainly used for allocating resources in Wireless networks. Robust Joint Congestion Control and Scheduling (RJDCS) are based on capacity, where new capacity is used for each network which addresses. This way efficiency and robustness of the network can be improved. The cloud resource based network and penalty based decentralized network have designed by [27, 28]. They considered various computational application through this network.

Ali Rostami et al. [29] enhanced the stability challenges and congestion control approaches for vehicular networks. The two algorithms which are used in this, linear adaptive and state-based approach Linear adaptive was the one with higher throughput and proved with better performance. Aloizio P Silva et al. [30] provided a survey on delay and disruption tolerant networks. The author showcased problems based on the connectivity faced by TCP based networks. Routing and congestion control was the main threat found in the survey. Based on the survey it can be understood that no perfect congestion control mechanism can be suited for all the above-said scenarios. Claudio Casetti & Mario Gerla [31, 32] proposed the congestion control mechanism for end-to-end networks. TCP Westwood (TCPW) improves the performance challenges in TCP Reno for both wireless and wired networks. Reno makes use of three duplicate ACKs and faster recovery helps with sufficient bandwidth and leads to a reduction in window size. Chih-Chiang Wang & Khaled Harfoush [33] suggested the flexibility and better performance to the overall nodes in the network based on shortest path routing algorithm. The author proposed RASTER, where overlay in routing can be improved. This helps in encoding and aggregating the information regarding routing. Thus, this protocol helps in enhancing the performance of the network under suitable assumptions. Milena Radenkovic & Andrew Grundy [34] suggested a congestion control mechanism for delay-tolerant networks. Many nodes are saturated and unusable, and they remain isolated due to network traffic. Here CafRep was used, where it identifies the nodes that are congested and react towards them. CapRep performs better congestion control mechanism over another existing mechanism. It increases the performance, delivery ratio and reduces the data loss rates. A. Vijayaraj et. al [35] expressed and arranged the hubs in a system, and then find the hub with the highest degree of difficulty among all of them. The information needs to be transmitted to its final destination; therefore the facilitator hub is unified with the most extreme in-degree participant to construct the tree. Jingling Liu et. al [36] mentioned the queuing delay is something that is guaranteed by DLCC. It offers a delay correction mechanism that occurs as a result of clock skew and dynamic traffic.

Mohammed et al. [37, 38] intended in minimization of congestion occurrence as it optimizes the performance of the network and also satisfies the requirements of the end user. The queue management is done with the help of a probability function. The data burst could also be calculated using this mechanism. Tairan Zhang et al. [39] proposed a method of allocating proper network traffic and resource, achieve an optimal rate-reliability trade-off. This approach achieved an optimal rate-reliability tradeoff through minimal data transfer rate of each user and the performance of end-to-end reliability in busty traffic through adjusting the price of congestion. The result when compared with TCP, the DPCC achieves maximum network utilization in a network.

3 Problem Statements

We have collected different methods and its analysis from related work as Sect. 2 and found few difficulties which are mentioned as follows. Overload can negatively impact data transfer speeds. Hence congestion control is crucial on the internet. For controlling data transfer over the internet, administrators employ an active queue management (AQM) method called random early detection (RED) which is control the congestion of data. If we will use the drop-tail method of the Transport Control Protocol (TCP), the RED can help us fix a security hole caused by the protocol's default settings. But Parameter tuning is a problem with RED, however adaptive RED (ARED) fixes that by adjusting settings on its own. Thus, to overcome the above difficulties, we proposed the enhanced Blue algorithm to improve the performance for data transmission when congestion occurs.

4 Analysis of Active Queue Management

We have considered active queue management model called as RED for our proposed model. The basic principle of RED is to perform congestion control before queue overflows. Congestion is notified through dropping packets or marking incoming packets. Through the notification, the sender will reduce packet transmission rates. RED indicates congestion notification as per exceed of queue size and packets will be dropped. If there a change in dropping probability as per optimal value then the maximum threshold is invoked, and all incoming packets are dropped or marked as shown in Fig. 1. Due to earlier detection of congestion, issues like "Lockout" and "Full Queue" are rectified in RED. The passive queue management method like Drop Tail cannot be able to solve these issues. Packet delay is reduced by maintaining smaller queue size.

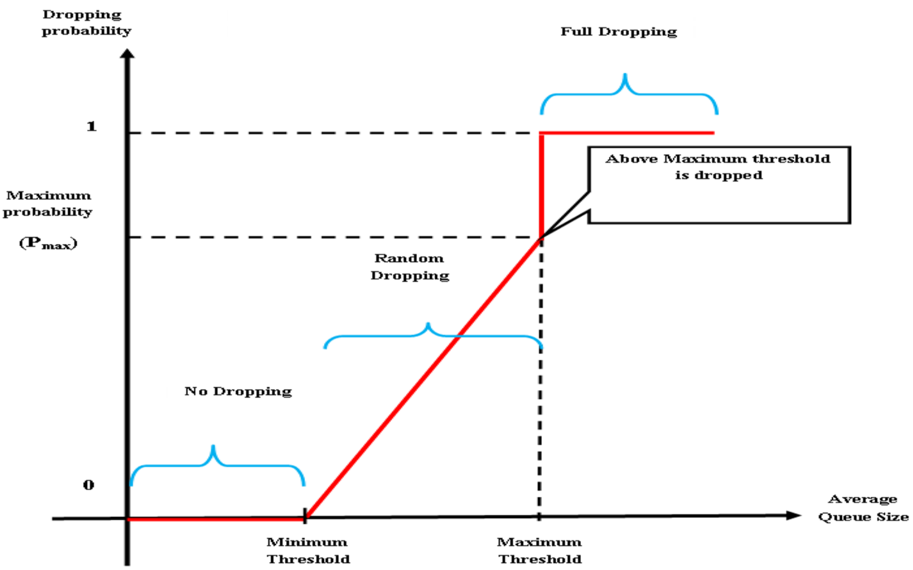

Fig. 1 Dropping probability of RED

The limitations of RED are replied speed, stability, the link between queue length and loss probability. To have good performance, RED parameters should be chosen correctly.

4.1 Using Blue Algorithm

To perform congestion control, the Blue algorithm works towards packet loss and link utilization. Blue algorithm uses queue length to determine congestion in the network which is different from all other Active Queue Management algorithms. A drop probability P_m is used to mark or drops the packet in Blue. If packets are frequently being dropped or marked due to a buffer overflow, P_m is incremented. When the queue is empty or idle, link probability P_m is decreased, i.e. Until the buffer is full or link become idle the dropping probability of Blue will not be increased. To prevent massive packet loss and long delay time during the higher buffer size, the limited queue can be set. Thus, when queue length reaches the queue limit, Blue algorithm acts like queue overflows. The performance can be increased using ECN with Blue. So, ECN can be enabled in both sender and receiver. The basic Blue algorithm is processes as follows.

Upon packet loss (or $Q > L$) event:	Upon queue empty or link idle event:
Min_Int ← New – Last_Update	Min_Int ← New – Last_Update
If (Min_Int > F_t) then	If (Min_Int > F_t) then
$P_m \leftarrow P_m + d_1$;	$P_m \leftarrow P_m - d_2$;
Last_Update ← New;	Last_Update ← New;

As per updated parameters like Freeze Time (F_t), d_1 and d_2, the P_m changes. When queue overflows, d_1 is increased by P_m when the queue is empty or idle link d_2 is decreased. From the above algorithm, Blue algorithm is simple in contrast to RED.

5 Proposed Congestion Avoidance Model Using Enhanced Blue Algorithm

We have designed Enhanced Blue Algorithm congestion avoidance by the updating the queue which is easy to forward the packets to the destination. The gateway compresses the packet and notifies the destination if its size is less than the minimum. The proposed work comprises of four processes; they are node creation, verification of size and data forwarding, data compression with notification and data backup based on acknowledgement. (a) In Node construction, a network is built with n-number of nodes, and all the nodes are interconnected with each other where each node request to each other. (b) The Second stage of the process is the verification of size and data forwarding, which checks the queue size through the enhanced blue algorithm. (c) In the next phase, data compression with the notification process is carried out. The gateway compresses the packet and transfers it to the target node with notice built on an over congestion notification algorithm for least queue length. (d) The final phase is Data backup that depends on acknowledgement. Performance evaluation of this technique provided higher throughput and reduced network congestion. The enhanced Blue algorithm is cast-off to avoid packet loss in the TCP by checking the queue size. If the size of the queue is high, at that time the packets are sent to destination directly from the gateway. The gateway delivers the compressed packet to its destination if the size is smaller. The destination replies with the acknowledgement through the gateway to the sender. For negative acknowledgement, the packet is retransmitted by the gateway to the destination as shown in Fig. 2. The details of above process are explained below.

5.1 Node Construction

Initially, the network of n nodes is constructed. Every node in the network is connected to each other for any kind of data requesting/sending. The network maintains the identifiers as ID of each node, and other data and also monitors Node's Communication to ensure security.

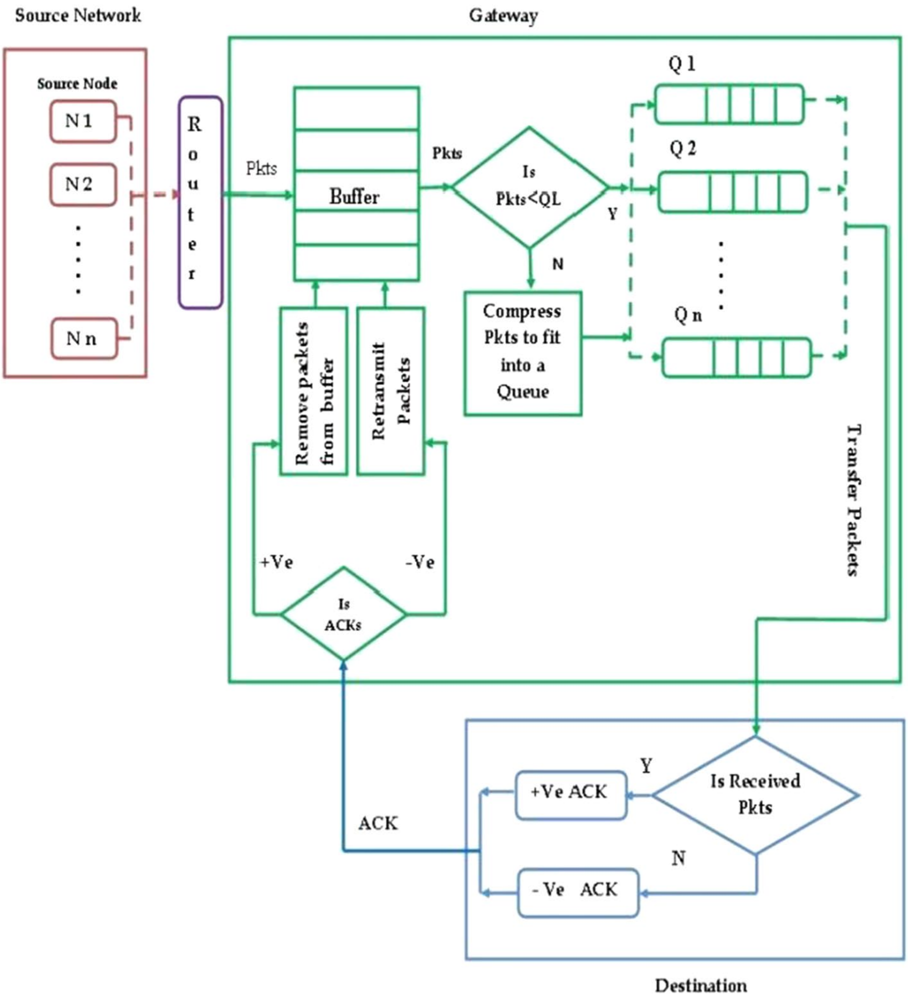

Fig. 2 System Architecture diagram of congestion control for Enhanced Blue Algorithm

Enhanced Blue Algorithm
For ∀ Pkt_1 to Pkt_n do
For ∀ Q_1_Size to Q_n_Size do
If (Q_x_Size <= MAX) then
Transfer the Pkt_x using Q_x
Else
Compute Q_x _RemSize =Size (Q_x)- Q_x .freespace()
$CPkt_x$ ← (Compress (Pkt_x., Q_x _RemSize)
If (CPktx_Size <= Q_x_Size)
Q_x ← $CPkt_x$
For ∀ ACK from destination
If (ACK == 1)
Remove Pkt_x from gateway forward ACK to Source
Else
Retransmit Pkt_x

5.2 Verification of Size and Data Forwarding

After creating and connecting nodes, each packet transfer from source to destination using TCP network. The packets are sent via a gateway and the usage of the queue. Initially, the source sends the data to the destination node via a gateway, in the same instance if multiple source nodes send data to a destination through the gateway causes congestion. So, to reduce this kind of congestion in the proposed method, the gateway checks the size of the queue. In case, queue length is increased to optimum, the packet will be sent via the gateway and added to the queue.

5.3 Data Compression with Notification

We considered the Explicit Congestion Notification (ECN) algorithm for compress packet with least queue size. ECN is an extension of a RED algorithm that signals the congestion of packets. TCP senders and receivers are used by ECN. After receiving the marked Acknowledgement packet from the TCP receiver, the TCP senders initialize its congestion avoidance algorithm. ECN router parameters are shown Fig. 3.

5.4 Data Backup based on the Acknowledgement

The gateway monitors whether the acknowledgment is positive or negative. The gateway receives data from the backup and resends it to the destination node if the acknowledgement is negative. The Gateway eradicates the packet from the backup if the acknowledgment is positive.

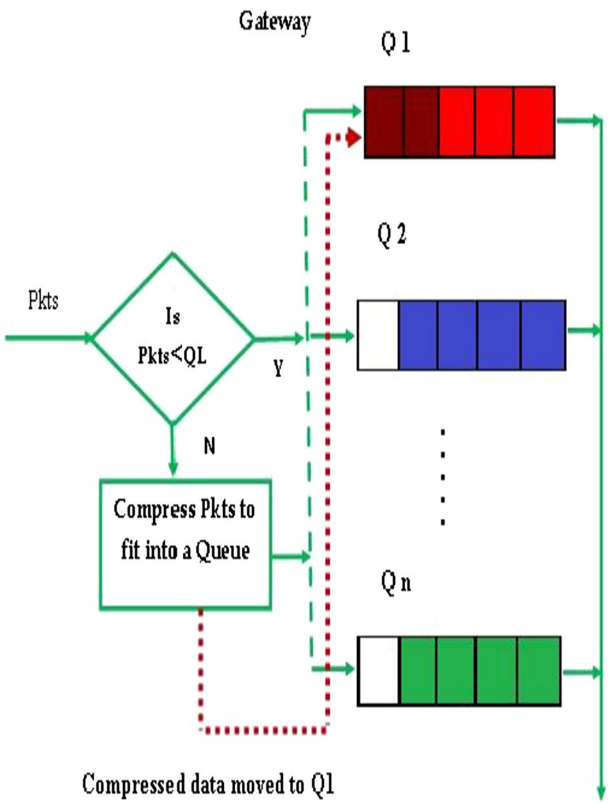

Fig. 3 Data compression

6 Simulation Analysis

For simulation, we considered NS2 simulator tool to determine the performance of the enhanced Blue algorithm against an existing EAODV system is evaluated. NS2 provides various simulating performance. A simulation trace file is created using the list of parameters as shown in Table 1.

6.1 Simulation Results

Initially, 50 nodes are constructed and arranged in a single point, later moved in a direction and traversed as Breadth-first tree order. Initially, start travelling from the peak node of the first level of tree to the neighbour node available, before moving to the second level of neighbours available. Breadth First Search (BFS) is memory efficient and comparing with the depth-first search, breadth-first is efficient because it is not required to complete fully. Any node can choose as a source in the destination node. Using breadth-first search algorithm the second level and above nodes are connected as shown in Fig. 4.

In Figs. 5 and 6 nodes choose the path to reach the destination node where the route 3 8 4327. Node 8 chooses the neighbour node 43 to reach the destination node 27. Each intermediary node maintains the buffer to store the information. Each intermediate node

Table 1 Parameter and Inputs

Parameters	Values
Simulator	Ns-allinone-2.34
Number of Nodes	50
Data Rate	10Mpbs
Buffer Size	51,200 bit
Number of Queues	5
Packet Size	128 bytes
Simulation area	1000 m*1000 m
Queue length	40
Traffic type	Constant Bit Rate(CBT)
Simulation Time	99 Sec
MAC Layer	802.11a, 802.11b
Routing Protocol	TCP with Blue Algorithm
Propagation Model	Two Way Ground
Channel Type	Wireless Channel

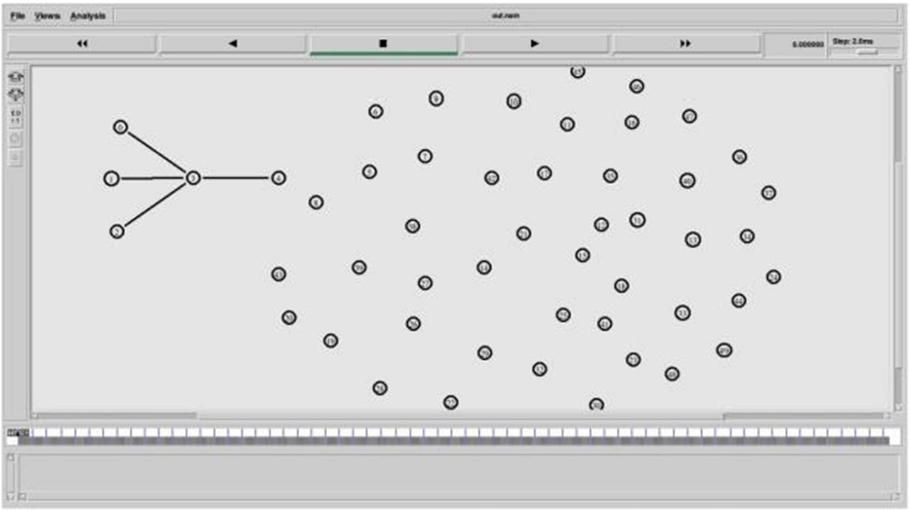

Fig. 4 Nodes construction

buffers the packet and forwards it to the neighbour. If congestion happens, the node detects congestion and will forward the message to its predecessor node to reach source node. The source node decreases the speed until congestion is removed.

As per the least queue length, compressed packet transfer to destination by gateway. For each packet transfer, the source node checked the acknowledgement and shown in Fig. 6. If the source node receives the positive acknowledgement then the gateway removes the data from the backup, i.e., the packet reaches the destination safely. If the

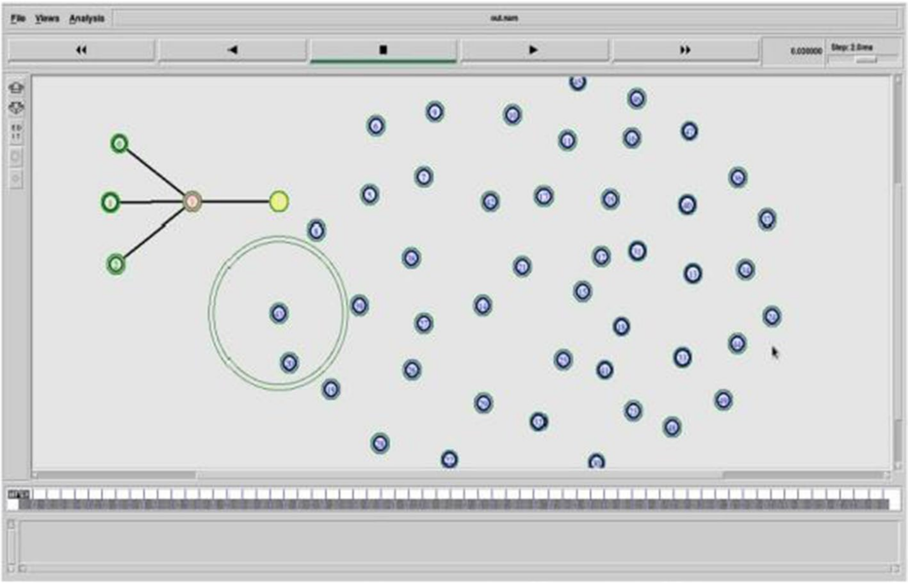

Fig. 5 Data transfer

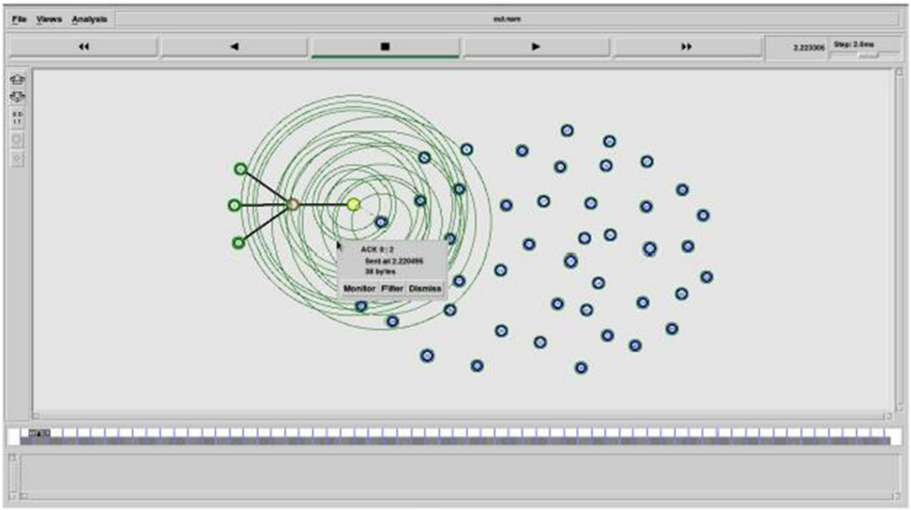

Fig. 6 Send the acknowledgement

gateway received a negative acknowledgement (packet loss), it retransmits the data to a destination node which is backed up. In Fig. 7 shows the packet loss.

For positive acknowledgement, packets are removed from backup. If it is a negative acknowledgement, the packet is retransmitted by using the gateway to the destination. Figure 8 shows the Retransmission of the packet.

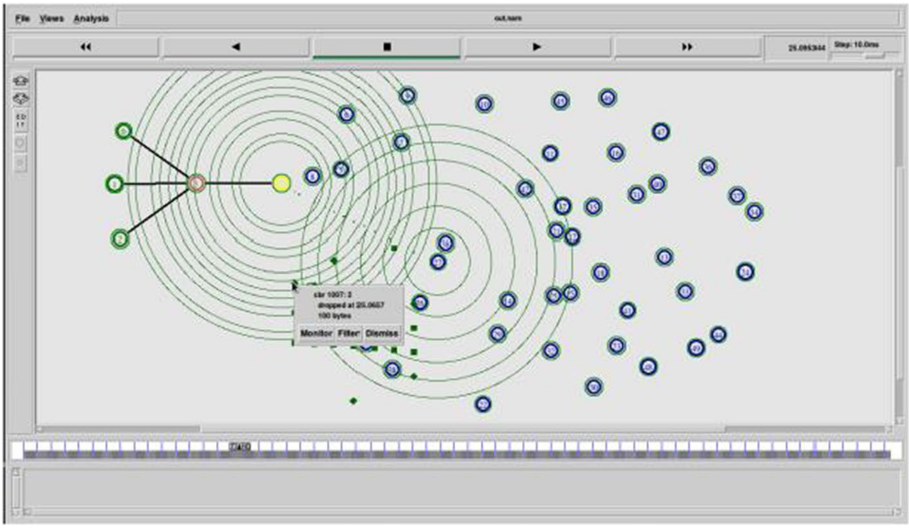

Fig. 7 Data Loss in network

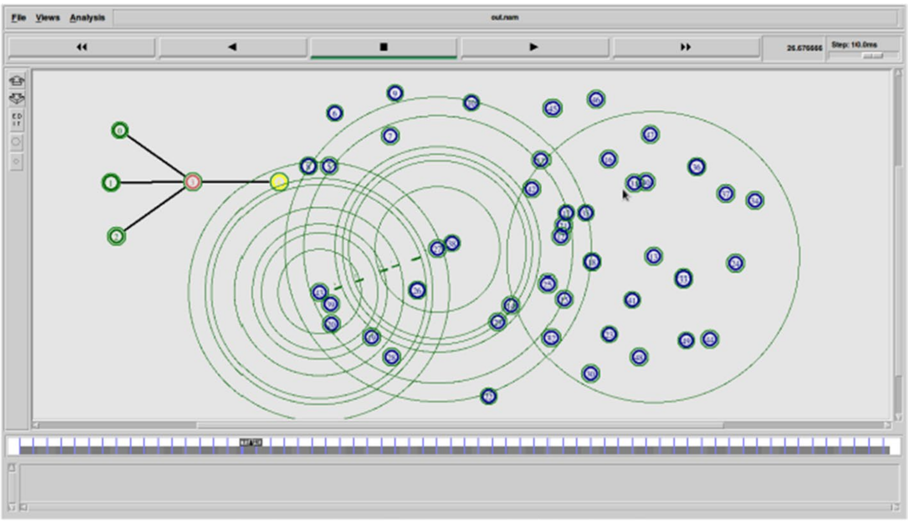

Fig. 8 Retransmission of packet

6.2 Performance Comparison

The main problem of TCP in a MANET environment is congestion network that performed on packet loss. The EBA lessen the packet loss through the method of queue size estimation. The gateway compresses the data packets and transfers them to the destination if the packet size is set to Maximum. After reaching the packet to the destination, it acknowledges the gateway. The acknowledgement from the destination is verified

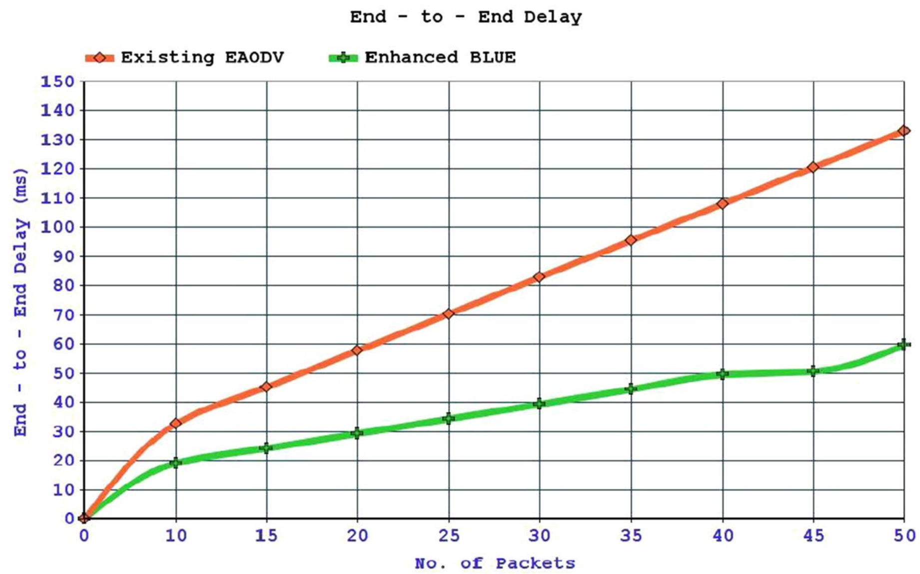

Fig. 9 End-to-End Delay Comparison between Existing EAODV with Proposed Blue

Table 2 End-To-End Delay Comparison between AODV and Enhanced Blue algorithm

No. of Packets (128 Bytes / pkt.)	No. of Hops	Propagation Delay (ms)	Queue Delay EAODV (ms)	End to End Delay EAODV (ms)	Queue Delay Enhanced Blue (ms)	End to End Delay Enhanced Blue (ms)
10	5	0.002	22.52	32.63	9.009	19.11
20	5	0.002	47.55	57.75	19.019	29.22
30	5	0.002	72.57	82.88	29.029	39.34
40	5	0.002	97.60	108.01	39.039	49.45
50	5	0.002	122.63	133.14	49.050	59.56

by the gateway. This process improves the performance of the network and decrease congestion.

The performances comparative analyses of the enhanced Blue algorithm and the existing EAODV are done with different parameters. The following parameters are used for comparison between above two approaches: (a) End-to-End Delay, (b) Packet Delivery Ratio, (c) Packet Loss Ratio, (d) Throughput.

6.2.1 End-to-End Delay

Typically, end-to-end packet delays that vary from packet to packet in random packet methods are used to transport packets from source to destination nodes. Figure 9 above compares the average end-to-end delay between the Enhanced Blue algorithm and EAODV. Different packets were used to get the simulated results. Table 2 displays the outcomes produced by the Enhanced Blue algorithm.

In EAODV during the packet size of 10, the average end-to-end delay is 32.63 ms whereas in Blue, the average delay is only 19.11 ms. In both the cases if the number of packet transmission increases, the end-to-end delay also increases.

In the enhanced Blue Algorithm, multiple queues are maintained to avoid congestion. Through periodic monitoring of the size of the queue, packets are delivered to the destination. The above table result show that, the total packet transmission of 50, in existing EAODV, the average delay of 133.14 ms but in the enhanced Blue it is 59.56 ms, which is 73.58 ms less delay than EAODV. The simulation results show that the average delay in EAODV is higher than the enhanced Blue.

6.2.2 Packet Delivery Ratio

The discrepancy is happened as per received packets and the actual packets transferred during the relevant period is used to calculate the efficacy of packet delivery. Figure 10 compares the average Packet Delivery Ratio between the Blue Algorithm and the improved Blue algorithm. The simulation result shows the number of packets received at different periods.

Table 3 shows the results of packet delivery ratio at various levels from packets to packets. During 30th packet in EAODV, the receiver received 26 packets whereas in enhanced Blue algorithm, it received 28 packets. In either case, the number of packet

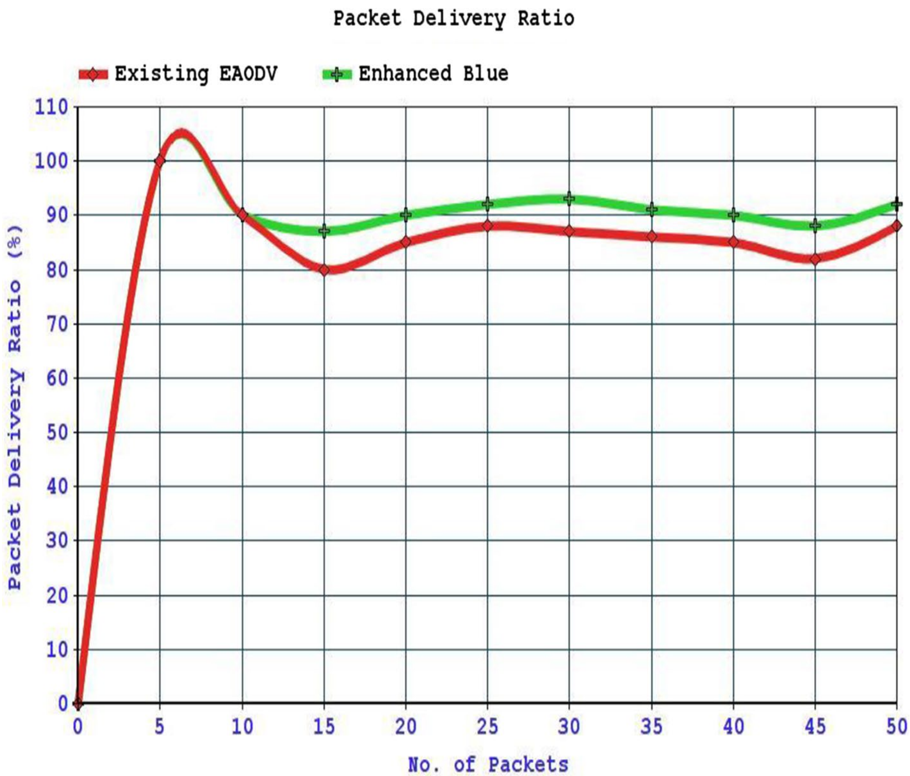

Fig. 10 Packet Delivery Ratio comparison between Existing AODV and Enhanced Blue algorithm

Table 3 Packet delivery ratio comparison

Number of Packets Sent (Sec)	Packet Delivery Ratio (in packets)	
	Existing EAODV	Enhanced Blue
5	5	5
10	9	9
15	12	13
20	17	18
25	22	23
30	26	28
35	30	32
40	34	36
45	37	40
50	44	46
Total	236	250
PDR	0.86	0.91

reception has proportionately increased. In this proposed work, a gateway node is deployed through which the packets are being transmitted. The gateway forwards each packet as per the threshold value of the queue size and compresses the packet, so multiple packets can be transferred at the same time which increases the Packet delivery ratio. The above table shows, the 50th packet delivered in existing EAODV, is 44 packets whereas in the enhanced Blue for 46 packets delivery, it is 2 packets higher than EAODV, i.e. 4% higher delivery ratio than EAODV. The simulation results show that average packet delivery in enhanced Blue is greater than the EAODV. The comparison of Packet delivery ratio between the existing EAODV and proposed Blue algorithm is shown in Fig. 10 and Table 3.

6.2.3 Packet Loss Ratio

During the transmission, some Packets fail to reach their destinations. The packet loss is determined by the difference between the total number of packets transmitted and the number of packets received by the receiver. Figure 11 displays the comparison of Percentage of Packet loss ratio between EAODV with enhanced Blue algorithm. The simulation result shows the percentage of data packets loss.

Table 4 shows the results obtained using blue algoritham. The sender transmitted 15 packets (i.e.128 bytes per packet), In existing EAODV the receiver received 20% of packet loss whereas in the enhanced Blue algorithm the packet loss is only 13.3%. In both cases, the percentage of packet loss has proportionately increased, but the packet loss ratio in the enhanced Blue is less because the percentage of packet drop is less due to the maintained multiple queues. In the proposed work, to reduce the packet loss, if the gateway receives the negative acknowledgement from the destination, it immediately retransmits the packets to the destination which is stored in the queue. The above table shows the average packet loss in existing EAODV at 12.9% when the receiver received all 50 packets but in enhanced Blue, the packet loss is only 10.7% which proves that the enhanced Blue algorithm is efficient than EAODV.

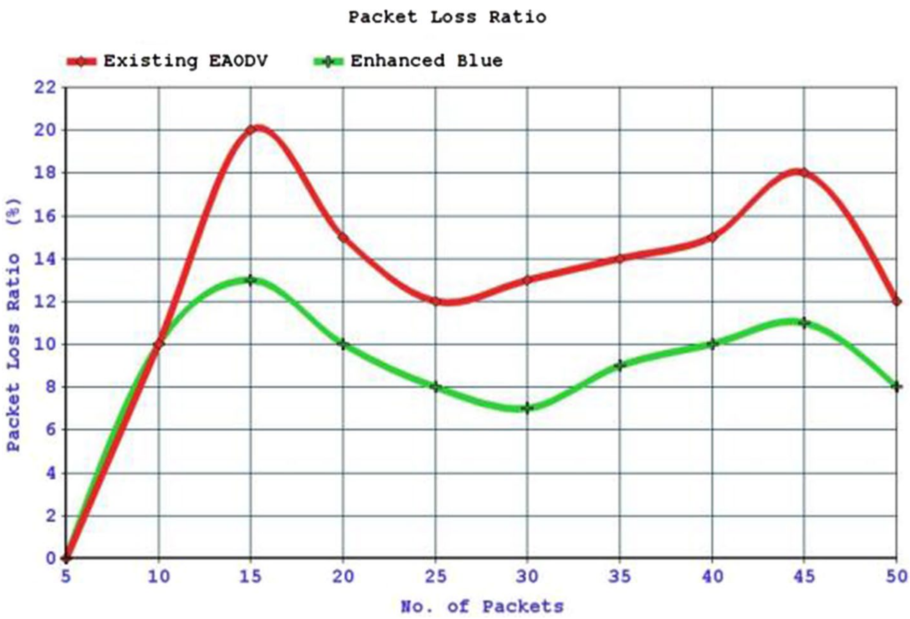

Fig. 11 Packet Loss Ratio comparison between Existing AODV and Enhanced Blue algorithm

Table 4 Packet loss ratio comparison

No. of Packets (128 Bytes / pkt.)	Existing EAODV	Enhanced Blue
	Packet Loss (%)	
5	0	0
10	0.100	0.100
15	0.200	0.133
20	0.150	0.100
25	0.120	0.800
30	0.133	0.0.067
35	0.142	0.085
40	0.150	0.100
45	0.177	0.111
50	0.120	0.800
Average Packet Loss	0.129	0.107

6.2.4 Throughput

The total numbers of packets were sent from the source to the destination in a given amount of time.

Figure 12 shows the assessment of throughput between enhanced Blue algorithm with the Existing EAODV. The simulation result shows the Average throughput over different packets over different times.

Table 5 shows the results obtained using blue algoritham. In a 20th hop, the sender could transmit only 15.547 Mbps in existing EAODV. In the enhanced Blue algorithm,

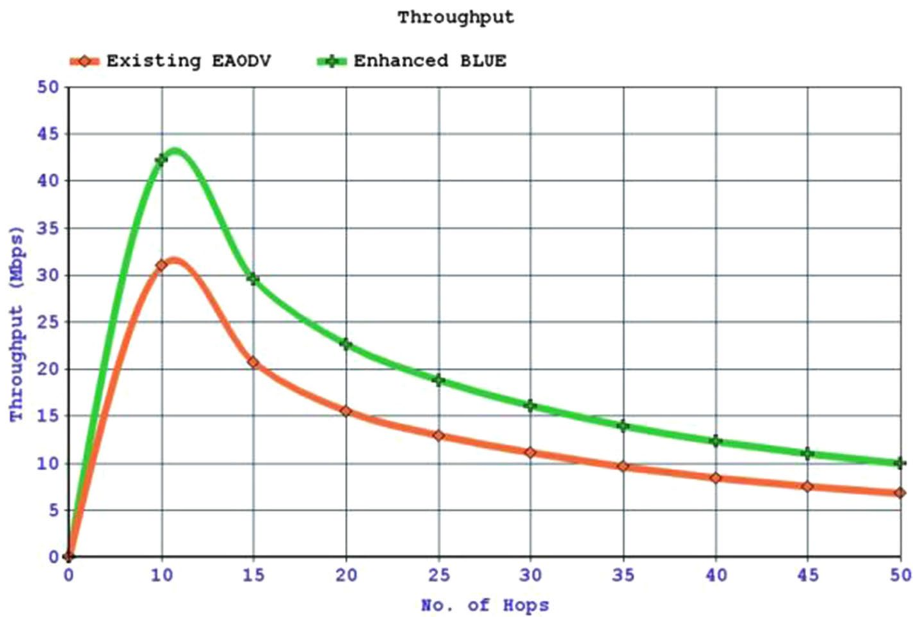

Fig. 12 Throughput comparison between Existing EAODV with enhanced Blue algorithm

Table 5 Throughput Comparison between AODV and Enhanced Blue algorithm

Number of Hops	Packet Size (MB)	EAODV (Mbps)	Enhanced BLUE(Mbps)
10	1	30.941	42.230
20	1	15.547	22.645
30	1	11.121	16.108
40	1	8.423	12.303
50	1	6.779	9.952
Average throughput	14.562	20.647	

it transmits 22.645 Mbps. In both cases, the proportion of throughput has decreased. In the proposed work, to avoid congestion and to increase throughput an explicit congestion notification algorithm is included at the gateway and also used enhanced Blue algorithm to monitor the queue size to compress the packets. The above table shows that the average throughput in existing EAODV is 15.562 Mbps. But in the blue algorithm, the average throughput is 20.647 Mbps which is 5.085 Mbps higher than EAODV. This proves that the proposed algorithm is efficient than an existing algorithm.

7 Conclusions

In this paper, the enhanced Blue Algorithm is applied to calculate the capacity of the node which is utilized to find the middle path. It also avoids congestion by monitoring the size of the queue. This blue algorithm maintains 5 queues to store the incoming packets. If the queue size is maximum, packets are forwarded to the destination. According to an explicit congestion notification technique, the gateway compresses and passes the packet to the target node with notice if the size is the minimum. Here, the gateway checks for negative acknowledgement that it received. In the proposed work, to reduce the packet loss, if the gateway receives the negative acknowledgement from the destination, it immediately retransmits the packets to the destination which is stored in the queue. An explicit congestion notification algorithm is included at the gateway to avoid congestion and to increase throughput. Multiple packets can be transferred in a stipulated time which increases the Packet delivery ratio. This proves that the proposed algorithm is efficient than an existing algorithm. The simulation results show between the existing EAODV with proposed Blue algorithm concerning different parameters. The packet delivery ratio has increased by 5%, throughput has increased by 5.085 Mbps, end-to-end delay has decreased by 1.13 s and packet loss is also decreased by 2.2%. It shows that the proposed Enhanced blue is comparatively better than the existing EAODV. This paper discussed the various existing algorithms like RED, blue algorithm and simulated the proposed Enhanced Blue algorithm effectively. Our enhanced framework will be developed using probability fuzzy model to avoid data congestion in future.

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Code availability Code is available with authors, but couldn't disclose due to future work.

Declarations

Conflict of interest No conflict of interest.

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