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AN INTEGRATED BANDWIDTH AND THROUGHPUT OPTIMIZED SCHEME FOR EFFICIENT MULTICASTING

R.Venkatesan* and P. Sivanesan**

Abstract: Multicasting is a significant operation that provides communication between users in a group manner. Optimizing the throughput and increasing the bandwidth utilization is a difficult issue. In addition to the traditional multicast routing protocols followed, recent multicasting schemes followed adaptive Beamforming and multipath power control transmission increasing robustness and minimizing end-to-end packet delays. However, the bandwidth consumption reduced with the increase in the robustness and therefore minimizing rate of throughput. In this work, to improve the bandwidth rate and throughput with minimum execution time, an integrated Bandwidth and Throughput Optimized scheme for Efficient Multicasting (BTO-EM) is designed. We initially present the design and implementation of Neighbor Routing Table based Bandwidth-Quality (NRT-BQ) metrics in BTO-EM framework. The NRT-BQ addresses the problem of bandwidth efficiency by proposing efficient algorithm based on the neighboring node bandwidth. Next, a Markovian-based Data Packet Transmission strategy is designed aiming at reducing the time taken to obtain optimal route path. This is achieved by evaluating number of receiver and non receiver nodes. Finally, Tree-based Multicast Throughput is constructed with the objective of improving the rate of throughput based on the number of data packet transmission, data packet transmission for 'nth tree' and data packet transmission for each session. This ensures the increased rate of throughput and therefore improving the overall network. Extensive simulations are conducted to evaluate the performance of BTO-EM. The experimental evaluation is carried out on the factors such as bandwidth, time delay, throughput, node density, number of data packets sent in the network. Experimental analysis shows that BTO-EM framework is able to reduce the average delay time for obtaining the route by 37.99% and improve the rate of bandwidth by 8.50% compared to the state-of-the-art works.

Keywords: Multicasting, Beamforming, Bandwidth, Throughput, Neighbor Routing Table, data packet transmission, Tree-based multicast

1. INTRODUCTION

One of the advantages of networks is the minimal configuration time and quick deployment, resulting in multicast efficiency. However, many types of networks suffer from minimum amount of resources and bandwidth utilization that attract many researchers. Several techniques and methods have been proposed to increase the throughput and bandwidth rate. In [1], an Adaptive Beamforming system was introduced with the objective of increasing the rate of robustness for multicasting in wireless network. Efficient multicasting method for under water sensor networks was designed in [2] using multipath power control transmission scheme with the aim of reducing the end-to-end packet delays.

Beaconless forwarder planarization [3] was introduced to reduce the number of nodes ready in the channel for transmission. The concept of routing tables was applied in [4] to address problems related to bandwidth intensive using longest prefix matching. The prioritization concept during forwarding was introduced in [5] to improve multicast efficiency with the aid of router packet. However, the above said

* AP-II,SOC IT,SASTRA University,Tanjore. Email:venkatesan.phd2012@gmail.com.
** AP-III SOC ICT SASTRA University,Tanjore.

methods suffer from higher throughput rate which is addressed in the proposed work using Tree-based Multicasting.

Though the design of ad hoc networks is easy and considered to be are cost-effective, but the network performance of ad hoc networks is limited with the increase in the node interferences making the design more complex. In [6], a distributed multi-channel MAC protocol was designed with the aim of improving the rate of throughput using dynamic switching protocol. With the objective of enhancing the rate of throughput, hill climbing key dissemination approach was used in [7]. The approach was also proved to consume lower memory in high dynamic sensor networks.

Another multi channel scheduler was designed in [8] aiming at improving the packet delivery ratio. An analytical throughput model was introduced in [9] to improve the rate of throughput. A beacon assisted spectrum access model was constructed in [10] to obtain achievable throughput by considering bandwidth cost. However, the execution time for attaining maximum throughput was not addressed, which is introduced in the proposed framework through Markovian-based Data Packet Transmission strategy.

Resource sharing in a distributed manner is receiving great amount of interest due to the multicasting nature. In [11], contraction random walk algorithm and expansion random walk algorithm was designed to improve the rate of throughput in an efficient manner. In [12], dynamic routing for data integrity was measured in an efficient manner using multipath dynamic routing protocol ensuring data integrity and reducing delay.

In [13], energy efficient reliable routing was presented with the objective of improving the lifetime and reliability of the network. Localized multicast was designed in [14] with the objective of reducing the communication and memory costs using single deterministic and parallel multiple probabilistic cells. A scheme based on multicast authentication was introduced in [15] with the aim of reducing the packet loss. However, the methods presented above did not consider the bandwidth channel capacity which is addressed in our work using neighbor routing table.

In [16], with the objective of improving the overall throughput and fairness, multi packet reception capability was introduced. With the aim of maximizing the throughput, in [17], cooperativeness versus non cooperativeness were studied for observing packet level constraints. The constraints related to packet were addressed using flow level constraints. An integrated framework to minimize the delay and maximize the lifetime of the network was introduced in [18] in any cast network. Optimal scheduling was achieved in [19] using Mixed Integer Non Linear Programming model. In [20], deployment strategies based on relay node was designed with the objective of improving the lifetime and therefore the connectivity of the network.

Based on the aforementioned techniques and methods, in this paper an integrated Bandwidth and Throughput Optimized scheme for Efficient Multicasting (BTO-EM) is presented. The contributions of BTO-EM framework include the following: (i) to improve the bandwidth efficiency by designing neighbor routing-table based bandwidth quality metrics, (ii) to reduce the execution time for optimal route path using Markovian-based data packet transmission strategy and (iii) to improve the rate of throughput by designing tree-based multicasting.

The remainder of this paper is organized as follows: In Section 2, the system models with the proposed framework Bandwidth and Throughput Optimized scheme for Efficient Multicasting (BTO-EM) are described. The deployment strategies are proposed and the impact of deployment on bandwidth and throughput is discussed. In Section 3, the performance of the deployment strategies is evaluated and compared. In Section 4, discussion related to BTO-EM framework using the table value and graph form is presented. The paper is concluded in Section 5.

2. DESIGN OF BANDWIDTH AND THROUGHPUT OPTIMIZED SCHEME FOR EFFICIENT MULTICASTING

The limited number of channels and the shared nature of wireless network enforce certain constraints on quality of services during multicasting. In this section, we design a Bandwidth and Throughput Optimized scheme for Efficient Multicasting to improve the multicast efficiency in terms of bandwidth, throughput and minimizing the delay in obtaining optimal route path. Figure 1 shows the block diagram of BTO-EM framework.

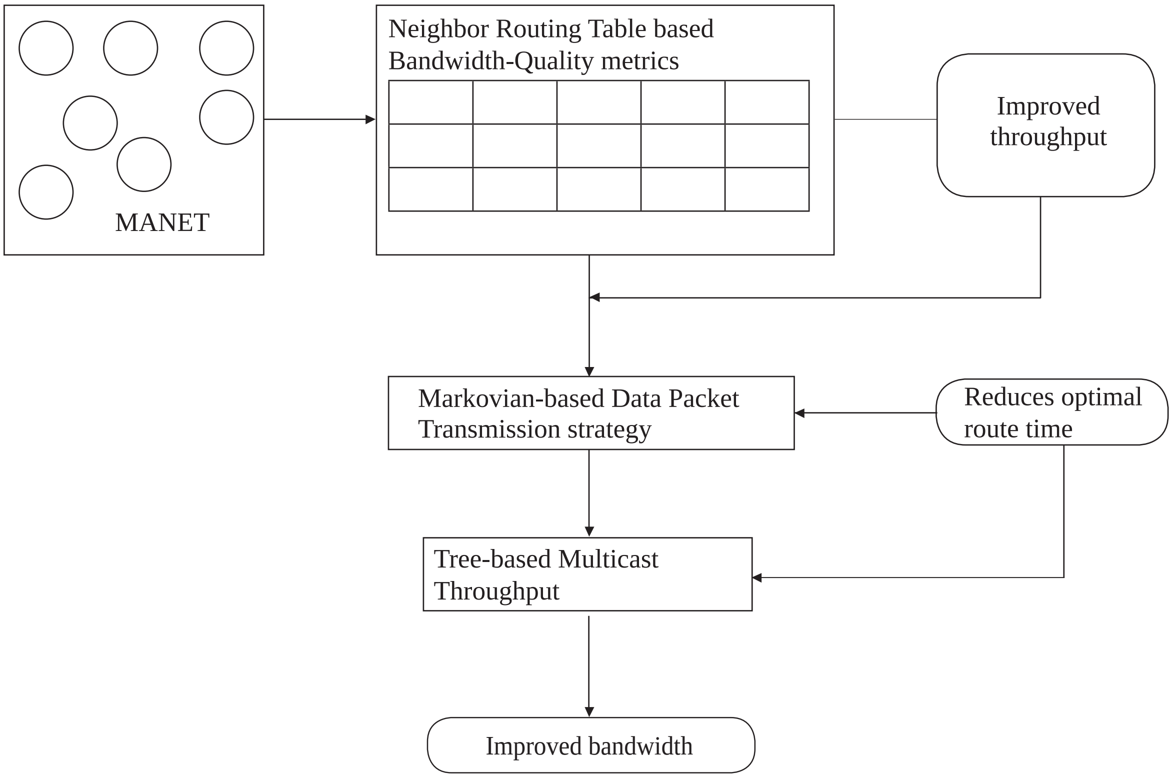

Figure 1. Block diagram of BTO-EM framework

Figure 1 given above shows the block diagram of BTO-EM framework. The components involved in the design of BTO-EM framework are (i) Neighbor Routing Table based Bandwidth-Quality metrics, (ii) Markovian-based Data Packet Transmission strategy and (iii) Tree-based Multicast Throughput. The Neighbor Routing Table based Bandwidth-Quality metric based on the neighbor routing table information is designed with the objective of improving the bandwidth rate. Next, Markovian-based Data Packet Transmission strategy aims at reducing the time in obtaining the optimal route path through Markovian states. Finally, the Tree-based Multicast Throughput improves the rate of throughput using session based data packet transmission. The elaborate description of BTO-EM framework is explained in the following sections.

2.1 Design of Neighbor Routing Table based Bandwidth-Quality metrics

To incorporate the new bandwidth-quality metrics into BTO-EM framework, the BTO-EM framework is designed as follows. Let us consider a communication network be designed as a directed, connected weighted graph denoted as '$Graph = (V, E)$' where 'V' represents the mobile nodes and 'E' represents the directed links. If a link, 'E' connects two mobile nodes 'MN_1, MN_2' in 'V', then it is denoted as '$e(MN_1, MN_2)$'. The mathematical formulation for each link is as given below.

$$V \rightarrow e(MN_1, MN_2) \tag{1}$$

From (1), the vertices '*V*' include a link '*e*' between two mobile nodes 'MN_1' and 'MN_2' respectively. Figure 2 given below shows the link establishment between mobile nodes with the objective of improving the bandwidth efficiency. The route path with highest bandwidth cost is selected as the optimal channel for data packet transmission. From the figure 2, there include a source node '*SN*', a destination node '*DN*' and intermediate node 'MN_1, MN_2, MN_3, MN_4, MN_5, MN_6 and MN_7' with varied bandwidth cost.

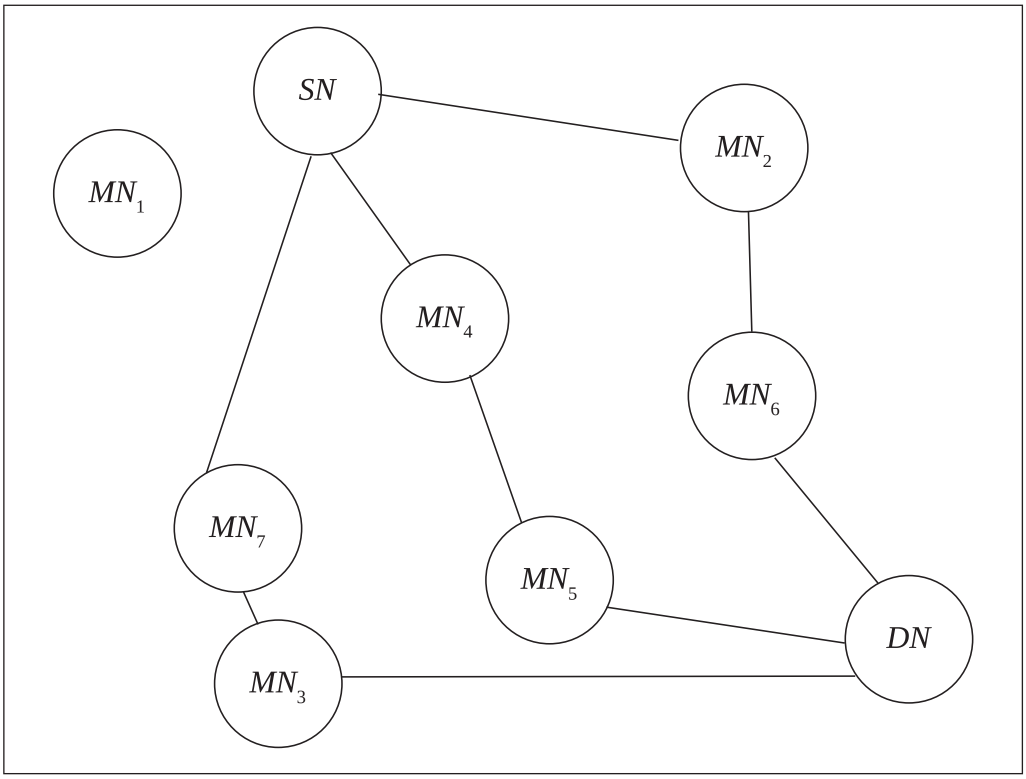

Figure 2. Mobile node representation with bandwidth-quality metrics

The proposed BTO-EM framework is designed in such a way that each mobile node '$MN_i = MN_1, MN_2, ..., MN_n$' maintains a routing table. The routing table records the list of route id, source node, destination node, route path and the bandwidth cost of the links from its neighbor nodes to itself and is mathematically formulation given as below.

$$RT = Route_{id}, SN, DN, RoutePath_i, BC \tag{2}$$

From (2), the routing table '*RT*' include table includes the route *id* '$Route_{id}$', source node '*SN*', destination node '*DN*', route path between source and destination nodes '$RoutePath_i$' and bandwidth cost '*BC*' respectively. Table 1 shows the routing table for the source node in figure that includes the list of source nodes, their destination node, route path and bandwidth cost.

Table 1. Routing table (different bandwidth cost for source node '*SN*')

Route ID	*Source Node*	*Destination Node*	*Route path*	*Bandwidth Cost (bps)*
RID_1	SN	DN	MN_2, MN_6	25 + 13 = 38
RID_2	SN	DN	MN_2, MN_6	33 + 12 = 45
RID_3	SN	DN	MN_2, MN_6	41 + 10 = 51

From the table given above, the highest bandwidth cost between source node '*SN*' and destination node '*DN*' flows through the route path 'MN_7, MN_3' with bandwidth cost '51'. The bandwidth costs are defined according to the bandwidth-quality metrics being used, and are periodically updated. In the proposed

BTO-EM framework each mobile node looks up the routing table for the cost of the bandwidth and uses this bandwidth cost, updates the cost of the bandwidth before rebroadcasting it to the neighboring mobile nodes.

Finally, when the source node reaches the destination node, it contains the total bandwidth cost of the route path travelled. Instead of selecting a route path immediately from the source node, the framework BTO-EM waits for a period of 'δ' milliseconds. During this waiting period of 'δ' milliseconds the BTO-EM obtains several route paths between the source node and destination node. The route path with highest bandwidth cost is selected as the best route path between the source and destination nodes. This in turn improves the multicast efficiency in terms of bandwidth with highest bandwidth cost being selected as the best route path between source and destination nodes.

Figure 3 given below shows the algorithmic description of efficient route path selection with highest bandwidth cost.

Input: Mobile Nodes '$MN_i = MN_1, MN_2, \ldots, MN_n$', Source Node '*SN*', Destination Node '*DN*', Route Path '*DN*' Rout Path '$RP_i = RP_1, RP_2, \ldots, RP_n$'
Output: Efficient route path with highest bandwidth cost
Step 1: **Begin** Step 2: **For** each source node and destination node ''*DN* Step 3: Identify the route paths Step 4: Measure the bandwidth cost Step 5: Select best route paths with highest bandwidth cost Step 6: **End for** Step 7: **End**

Figure 3. Highest Bandwidth Cost-based Route Path Selection algorithm

As shown in the figure 3, between each source node and destination node, with the objective of improving the bandwidth efficiency during multicasting, the possible route paths between the '$S - D$' pair is identified. Based on the identified route paths, the bandwidth cost between the '$S - D$' pair is measured. The route paths with highest bandwidth cost are then selected as the optimal route path improving the bandwidth efficiency during multicasting.

2.2 Design of Markovian-based Data Packet Transmission strategy

Once, the best route paths are selected between the '$S - D$' pair, our goal is to design a data packet transmission strategy that minimizes the time taken to obtain the optimal route path. This is achieved in the BTO-EM framework by applying a Markovian-based Data Packet Transmission strategy.

The Markovian-based Data Packet Transmission strategy uses a threshold factor data transmission strategy where Sender Node (i.e. source node) selects a threshold factor for each '$S - D$' pair. The threshold factor for each '$S - D$' pair is selected in such a manner only when the number of ready receivers (*i.e.* intermediate mobile node) exceeded the selected threshold factor.

Let mobile nodes '$MN_1' = MN_2, \ldots, MN_n$' represent a vector of mobile nodes where the mobile node '$MN_i = 1$' if the mobile node 'MN_1' is receiver node. With this, the delay time to obtain the optimal route path is reduced because only if the mobile node is the receiver node, it is selected for route path identification. On the other hand if the mobile node '$MN_i = 0$', the mobile node 'MN_1' is not the receiver node and is mathematically formulated as below.

$$MN_1' = MN_2, \ldots, MN_n \tag{3}$$

if '$MN_i = 1$' mobile node 'MN_1' *receiver* node, (4)

otherwise mobile node 'MN_1' is not receiver node (5)

The Markovian-based Data Packet Transmission strategy readiness states are independent and identically distributed. Here, the expected time for termination for each '$S – D$' pair is mainly based on the number of satisfied receiver mobile nodes 'MN_{sr}' and the number of unsatisfied receiver mobile nodes 'MN_{usr}'. Then the mathematical formulation for Markovian-based Data Packet Transmission is given as below

$$MN_{sr} = \sum_{i=1}^{n} MN_i' \tag{6}$$

$$MN_{usr} = \sum_{i=1}^{n} MAX\ (RT - MN_i') \tag{7}$$

From (6) and (7), number of satisfied receiver mobile nodes 'MN_{sr}' and number of unsatisfied receiver mobile nodes 'MN_{usr}' are evaluated in an efficient manner reducing the time to obtain the optimal route path.

Input: Vector mobile nodes 'MN_i'' = MN_1, MN_2, … , MN_n',
Output: Optimal route path selection minimizing delay time
Step 1: **Begin** Step 2: **For** each vector mobile nodes MN_i' Step 3: Select receiver node Step 4: ***if*** '$MN_i = 1$' **then** Step 5: mobile node 'MN_1' is receiver node Step 6: Measure number of satisfied receiver mobile nodes using (6) Step 7: Measure number of unsatisfied receiver mobile nodes using (7) Step 8: **else** Step 9: Step 10: **End if** Step 11: **End for** Step 12: **End**

Figure 4. Optimal route path selection algorithm

The above algorithm in figure 4 describes the optimal route path selection based on the vector mobile nodes. The vector mobile node is checked to identify whether it is a receiver node or a non-receiver node. If the vector mobile node is a receiver node, then the number of satisfied receiver mobile nodes is measured. If the vector mobile node is not a receiver node, then the number of unsatisfied receiver mobile nodes is measured. In this way, based on these two types of nodes, optimal route path selection is made in an efficient manner.

2.3 Design of Tree-based Multicast Throughput

Finally, an integrated Bandwidth and Throughput Optimized scheme for Efficient Multicasting (BTO-EM) using multicast throughput with the objective of improving the multicast efficiency in terms of throughput is presented. Let us consider the vertices '$V = MN_1, MN_2, \ldots, MN_n$' denotes the set of mobile nodes in the network and '$SN \in V$' represents the source node of multicast that belongs to the vertices 'V', with the number of multicast session represented by '$Session \rightarrow n_{sn}$'. Then, the achievable multicast is formulated as given below

$$DN_{s,i} = v_{sn1}, i_1, v_{sn2}, i_2, \ldots, v_{snn}, i_n \tag{8}$$

From (8), for each source node 'sni', there exists a random node 'i_n' is uniformly selected from a set '$DN_{s,i}$' as the set of destination nodes in network with the objective of increasing the rate of throughput. The proposed framework BTO-EM is based on the unique tree with a specific bandwidth. In Tree-based Multicast Throughput, a session is built only if a routing tree with suffice bandwidth is established.

In the proposed framework BTO-EM using Tree-based Multicast Throughput, the traffic network based on the on-demand multicast is considered, where during each session a specific tree is created with specified bandwidth. As a result, the network is said to be free from collision by sending the data packets throughput non-overlapping channels or sending the data packets at different time slots. This therefore results in improved rate of throughput and is mathematically formulated as given below

$$NDP_t = \Sigma_{i=1}^{n} M_{i,nc}^{j} \tag{9}$$

From (9), the number of data packet transmissions 'NDP_t' is arrived using the non overlapping channels 'nc' and if '$M_i^j = 1$' a data packet is being forwarded in the channel and if '$M_i^j = 0$', no data packet is being forwarded through the channel. Therefore, the total number of data packet transmission for the 'n^{th} *tree*' is then obtained as given below

$$NDPT_n = \sum NDP_t, \text{ where } t \in V \tag{10}$$

From (10), the number of data packet transmission per session is then formulated as given below

$$NDPT^{n'} = \Sigma_{n=v}^{vsni} NDPT^{n} \tag{11}$$

From (11), per session flow of data packets in each network during each session is analyzed in an efficient manner, improving the rate of throughput. Figure 5 shows the algorithmic description of Tree-based Multicast Throughput.

Input: Mobile Nodes '$MN_i = MN_1, MN_2, \ldots, MN_n$', Vertices '$V$', Sessions '$n_{sn}$',

Output: Throughput optimized network

Step 1: **Begin**
Step 2: **For** each Mobile Nodes MN_i
Step 3: **For** each session s
Step 4: Measure data packet transmission using (9)
Step 5: Measure total data packet transmission for '*nth tree*' using (10)
Step 6: Measure data packet transmission per session using (11)
Step 7: **End for**
Step 8: **End for**
Step 9: **End**

Figure 5. Tree-based Multicast Throughput algorithm

Figure 5 shows the algorithmic description of Tree-based Multicast Throughput algorithm. The Tree-based Multicast Throughput algorithm includes three steps. For each mobile nodes and each session, the rate of data packet transmission, the total data packet transmission for '*nth tree*' and data packet transmission per session is measured. This ensures the increased throughput rate, improving the overall network design.

3. EXPERIMENTAL SETTINGS

Bandwidth and Throughput Optimized scheme for Efficient Multicasting (BTO-EM) framework uses the NS-2 simulator with the network range of 1500 * 1500 m size. The BTO-EM framework uses 70 mobile nodes for experimental purpose. To conduct experimental work, Destination Sequence Based Distance Vector DSDV is used as routing protocol for BTO-EM framework.

The BTO-EM framework's moving speed of the mobile nodes is about 5 m/s for each mobile node with a simulation rate of 50 milliseconds to perform data packet transmission between mobile nodes. The parametric values for performing experiments are shown in table 2.

Experiment is conducted on the factors such as bandwidth, execution time, throughput, ratio for efficient data packet transmission during multicasting. The results of the metrics of the BTO-EM framework is compared against the existing methods such as Adaptive Beamforcing System for Multicasting (ABS-M) [1] and Efficient Multicast Communication for Underwater Sensor Networks (EMC-USN) [2] respectively.

Table 2. Simulation setup

Parameter	*Value*
Protocols	DSDV
Network range	1500 m * 1500 m
Simulation time	50 ms
Number of mobile nodes	10, 20, 30, 40, 50, 60, 70
Packets	7, 14, 21, 28, 35, 42, 49
Network simulator	NS 2.34
Mobility speed	5 m/s
Pause time	10 s

4. DISCUSSION

The result analysis of Bandwidth and Throughput Optimized scheme for Efficient Multicasting (BTO-EM) framework is compared with existing Adaptive Beamforcing System for Multicasting (ABS-M) [1] and Efficient Multicast Communication for Underwater Sensor Networks (EMC-USN) [2] respectively. Table 3 represents the bandwidth efficiency with different data packets using NS2 simulator and comparison is made with two other methods, namely ABS-M [1] and EMC-USN [2].

4.1 Impact of bandwidth rate

The bandwidth refers to the channel capacity through or physical communication path in a communication system that measures the maximum throughput of a network. The rate of bandwidth is mathematically formulated as given below.

$$B = DP_s - DP_d \tag{12}$$

From (12), bandwidth '' refers to the difference between the data packet sent 'DP_s' (in terms of bits) to the data packets dropped 'DP_d' (in terms of bits). Higher the bandwidth, more efficient the method is said to be and is measured in terms of bits per second (bps).

Table 3. Tabulation for bandwidth

Data Packets (bits)	*Bandwidth (bps)*		
	BTO-EM	*ABS-M*	*EMC-USN*
100	80	75	68
200	175	155	145
300	245	225	205
400	355	335	320
500	482	462	447
600	540	520	505
700	630	610	600

Figure 6 given below shows the rate of bandwidth for data packet at the receiving end with respect to different number of data packets sent which is measured in terms of bits. To better perceive the efficacy of the proposed BTO-EM framework, an extensive experimental results are illustrated in Figure 6 and compared against the existing ABS-M [1] and EMC-USN [2] respectively. The results reported above confirm that with the increase in the number of data packets being sent during multicasting, the data packets being transmitted at the destination end also increases and comparatively observed to be higher using BTO-EM framework. So, the framework BTO-EM is said to be efficient in terms of multicasting than compared to ABS-M [1] and EMC-USN [2] respectively.

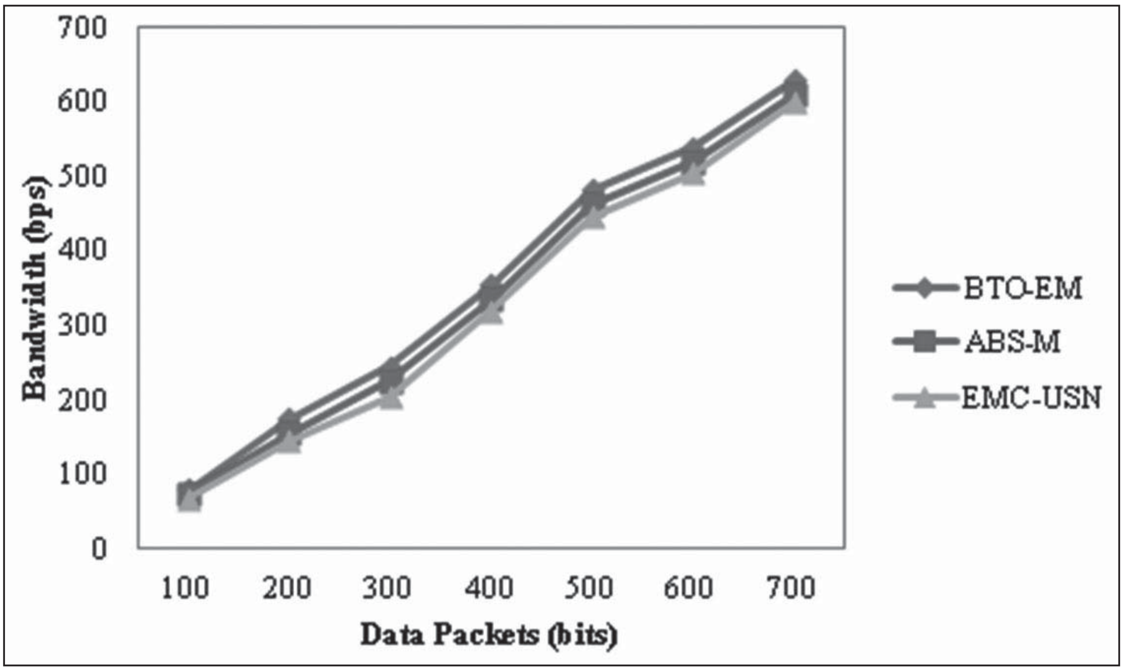

Figure 6. Measure of bandwidth rate

From the table 3, when data packets with 400 bits were sent, 355 bits were efficiently received at the receiving end (destination node) using the BTO-EM framework, whereas 335 and 320 bits were collected at the destination node using ABS-M and EMC-USM. The data bits collected at the destination node are improved with the application of Neighbor Routing Table based Bandwidth-Quality metrics. With the objective of improving the rate of bandwidth, Neighbor Routing Table identifies the bandwidth cost of the neighboring mobile node with the aid of routing table and the bandwidth cost of higher in nature is selected in an efficient manner. Therefore, the highest bandwidth cost route path is selected improving the rate of bandwidth using BTO-EM framework by 6.04% compared to ABS-M and 10.97% compared to EMC-USM.

4.2 Impact of execution time on obtaining optimal route path

The execution time to obtain the optimal route path is measured using the number of data packets being sent and the time for each data packet to be sent during multicasting. The mathematical formulation of execution time is as given below.

$$ET = \Sigma_{i=1}^{n} DP_i * Time \tag{13}$$

From (13), the execution time '*ET*' is the product of number of data packets sent 'DP_1' and the time for each data packets '*Time*' respectively. It is measured in terms of milliseconds (ms). Lower the execution time, more efficient the method is said to be.

The comparison of execution time for optimal route path is presented in table 4 with respect to the number of data packets ranging from 10 to 70 taken up for experimental purpose. With difference noted in the number of data packets, though the increase in the increases in the execution time is not linear, but BTO-EM framework proved to be better than the state-of-the-art works.

Table 4. Tabulation for execution time

No of Data Packets sent (n)	*Execution time for optimal route path (ms)*		
	BTO-EM	*ABS-M*	*EMC-USN*
10	3.6	4.9	5.5
20	6.5	8.6	11.9
30	8.3	10.4	13.7
40	11.2	13.3	16.6
50	10.1	12.2	15.5
60	14.3	16.4	19.7
70	17.2	19.3	22.6

The targeting results of Execution time for optimal route path using BTO-EM framework is compared with two state-of-the-art methods ABS-M and EMC-USN and figure 7 is presented for visual comparison based on the relevant information. The figure shows the execution time with respect to number of data packets being sent, with each mobile nodes sending different data packets to the intermediate node and then to the destination node.

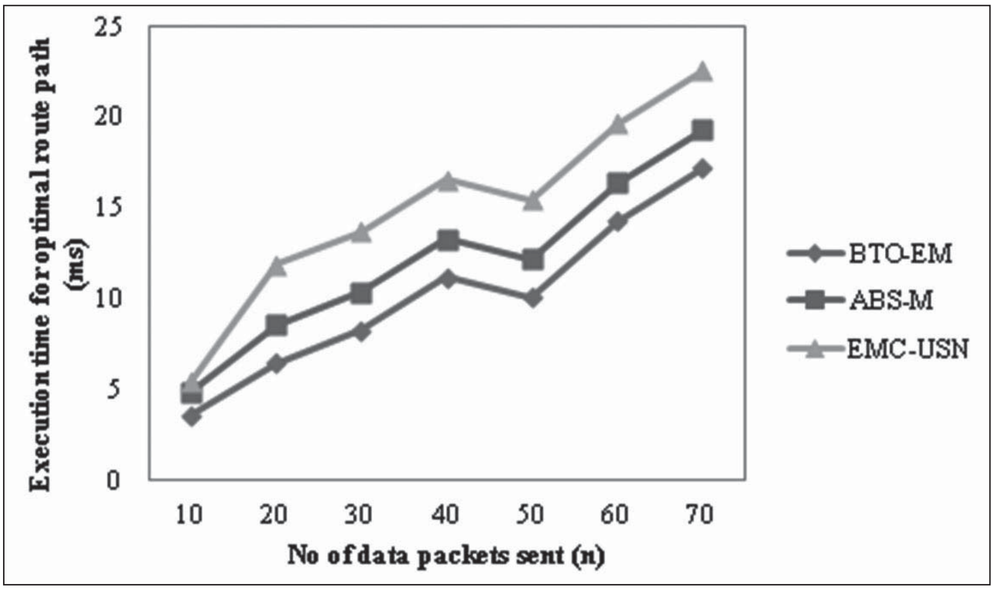

Figure 7. Measure of execution time for optimal route path

As illustrated in figure 7, when 40 data packets were transmitted, the execution time to obtain optimal route path using BTO-EM framework was 11.2 ms compared to ABS-M and EMC-USN that showed 13.3 ms and 16.6 ms respectively. Our framework BTO-EM differs from the ABS-M and EMC-USN in that we have incorporated Markovian-based Data Packet Transmission strategy. The advantage of using the Markovian-based Data Packet Transmission strategy in BTO-EM framework is that based on the satisfied receiver node, the route is selected that increases the optimality in route path being. This satisfied receiver nodes are then used for the communication between sender and receiver node which reduces the execution time for obtaining the optimal route path by 22.87% compared to ABS-M and 53.10% compared to EMC-USN respectively.

4.3 Impact of throughput

Throughput measures the successful data packets delivery over the communication channel and is measured in terms of packets per second (pps). The rate of throughput is mathematically formulated as given below

$$T = DP_s - DP_d \tag{14}$$

From (14), the throughput 'T' is the difference between the data packets sent 'DP_s' and the data packets received 'DP_d'. The average throughput rate of BTO-EM framework is elaborated in table 4. The framework was considered with packet size in the range of 10 to 70 for experimental purpose using NS2 simulator.

Table 4. Tabulation for throughput

No of Data Packets sent (n)	*Throughput (pps)*		
	BTO-EM	*ABS-M*	*EMC-USN*
10	7	6	5
20	16	14	12
30	22	20	17
40	28	25	22
50	43	40	39
60	55	52	49
70	60	56	52

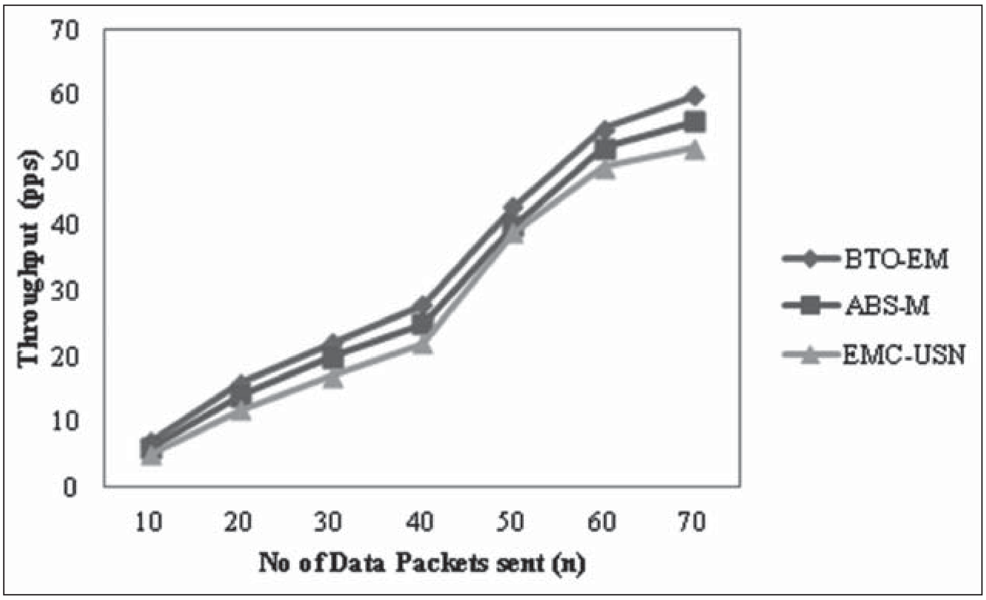

Figure 8. Measure of throughput

Figure 8 given above shows the measure of rate of throughput for BTO-EM framework, ABS-M [1] and EMC-USN [2] versus seventy different packets sent at different time intervals. The average rate of throughput over different time interval returned over BTO-EM framework increases gradually though not linear for differing number of packets being sent when compared to the two other methods. From figure 8, it is illustrative that the average rate of throughput is improved using the proposed BTO-EM framework. This is because of the application of Tree-based Multicasting which uses the number of data packet transmission based on the session which helps in improving the rate of throughput in a significant manner. The Tree-based Multicasting with the aid of data packet transmissions only after selecting the forwarding nodes, data packets are sent that improves the throughput rate by 9.38% compared to ABS-M and 18.75% compared to EMC-USN respectively.

5. CONCLUSION

This work presents a novel framework, Bandwidth and Throughput Optimized scheme for Efficient Multicasting (BTO-EM) with the objective of improving the rate of bandwidth and throughput by minimizing the time taken for optimal route path. The performance of the proposed framework is compared with multicasting methods (namely, ABS-M and EMC-USN). The proposed framework has the following advantages. (i) Improves bandwidth rate data packets being sent to the destination node and therefore improves the scalability, (ii) provides low execution time by efective way of using the Markovian-based data packet transmission strategy in order to identify the prospective intermediate nodes, (iii) representation of Tree-based Multicasting for achieving improved throughput rate. The bandwidth rate in BTO-EM framework is improved using Neighbor Routing Table based Bandwidth-Quality metrics that obtains bandwidth cost information based on the routing table. By applying bandwidth cost, the route having the highest bandwidth cost is considered to be the optimal route path and therefore bandwidth rate is improved significantly. With the application of Markovian-based Data Packet Transmission strategy, the average execution time is reduced by segmenting receiver and non receiver node in a significant manner. This in turn reduces the average execution time for obtaining the optimal route path for data packet transmission. Finally with the construction of Tree-based multicasting, the rate of throughput is increased considerably. Simulations were conducted to measure the performance of BTO-EM framework and evaluated the performance in terms of different metrics, such as bandwidth rate, execution time and throughput rate during multicasting. The results show that BTO-EM framework offers better performance with an improvement of throughput by 14.06% compared to ABS-M and EMC-USN respectively.

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