Message Size and TTL Based Congestion Control in Delay Tolerant Networks

Amardeep[1], Dr. Devendar Gahlot[2], Dr. H S Bindra[3], Ankita Garg[4]

[1]Deptt. of Computer Science, Gopichand Arya Mahila College, Abohar (Punjab)

[2]Deptt. of Computer Science, Govt. College of Engineering,,Bikaner (Rajasthan)

[3]Deptt. of Information Technology, MIMIT, Malout (Punjab)

[4]B.Tech., CSE, DR B R Ambedkar NIT Jalandhar (Punjab)

ABSTRACT

Sharing the information or the data is one of the most important requirements in this fast changing technological environment. So for this information sharing, set of devices are connected together to form a network. In modern world there are certain scenarios where the traditional wired or wireless networks cannot work. Under such stressful environment, Delay Tolerant Networks (DTNs) are deployed. The buffer management is one of the key areas for congestion control which need to be addressed in DTNs. In this paper, we have proposed a novel method for buffer management which takes into consideration the size of message and the remaining TTL for buffer management and for accommodation of new incoming message at each node. The results obtained by following this new approach suggest the improvement in the efficiency of the network under consideration.

Keywords : Delay Tolerant Network; Time to Live; Delivery Probability; Overhead Ratio; Congestion Avoidance

I. INTRODUCTION

Sharing the information or the data is one of the most important requirements in this fast changing technological environment. So for this information sharing, set of devices are connected together to form a network. These devices are connected together through communication links. These communication links could be wired or wireless. Traditional wireless networks such as Adhoc networks always guarantee the complete end to end path between two communicating nodes. But there are certain scenarios where we cannot guarantee the complete end to end path at all the times. These types of networks work under the stressful environment i.e. no ene-to-end path, excessive delays, high mobility, asymmetric data transmission rate etc.

Under this stressful environment or in such type of networks the traditional TCP/IP protocol suit [1] cannot work because the TCP/IP protocol suits are based on certain assumptions/requirements which are not met by these networks. Such networks are termed as intermittently connected networks (ICNs).

As the time passed the ere aroused the need of the passing of information between the various types of ICNs like wireless sensor networks (WSNs) and Internet [2,3]. For making this communication possible the use of gateways were made. These gateways make the exchange of protocol parameters between different ICNs by converting the protocol parameters into the form acceptable by the target ICN (as in Figure 1).

As in the case of the ICNs there could be long delays in between the two connections, so there is the need of the buffer space in the gateways so that they can hold the information for the time till the next contact opportunity arises. For the proper interaction and functionality under these challenging conditions researchers were pushed to develop a new networking concept. In open literature, it is known as a Delay or Disruption – Tolerant Networking (DTN). Over the last decade, DTN is a highly active area of research. The design of Architecture, the design of the application, routing, buffer management, congestion control are very pursuing issues in the area of research [4].

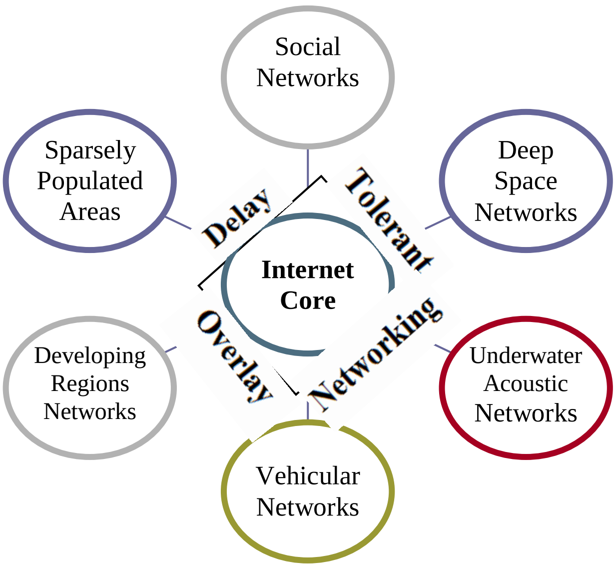

Figure 1: Delay Tolerant Networking

The Inter-Planetary Network (IPN), a task propelled in 1998 went for setting up availability between nodes subjectively situated on the diverse close planetary system planets. Deep space correspondence is additionally a sort of network where there extreme engendering delays, higher error rate, and successive interruptions. Accordingly, customary protocols neglect to transmit information bundles over such networks [5]. Customarily, we utilized TCP/IP protocol to send parcels from source to goal, which needs an ideal way to progress 100 percent. However, in DTN there isn't an assurance of end to end way, so web routers dispose of any message on the grounds that a connection is down. That outcome in information misfortune. In DTN, routers can be supplanted with DTN node, which has storage limit and in the later phase they send bundles of information. On the off chance that the connection is down DTN node will hold the information until the point that the connection comes up. DTN utilizes store-carry forward (SCF) system to send the information [6].

The web has TCP for dependability. In TCP, a connection is first settled. In the event that the information packet is lost, the sender will retransmit the packet. DTN utilizes hop by-hop custody exchange. Progressive node takes the custody, and the bundles move towards the goal. On the off chance that the bundle is lost and the custody isn't recognized by the following node, the last custodian retransmits the information. Information can be retransmitted from the nearest node instead of sender.

The requirement for DTN emerges on account of the three reasons – (I) Lack of connectivity implies where there is no end to end way amongst source and goal, we can't utilize TCP/IP protocol, rather we utilize DTN. (ii) Irregular Delays can make an issue for TCP/IP. This issue can be overwhelmed with the assistance of DTN. (iii) The Asymmetric bidirectional data rate can be endured to some degree in the customary protocol. Be that as it may, if the asymmetry is extensive then it can be crushed effortlessly [7].

DTN is a network of littler networks. The DTN is an overlay on existing systems. This overlay is called as bundle layer as appeared in Figure 2. This layer can go about as a gateway when two nodes interact with each other. DTN is adaptable it can be effortlessly connected with the current protocol. DTN design utilizes new addressing semiotics [8].

		Application
Application		Bundle
Transport		Transport
Network		Network
Link		Link
Physical		Physical

Original Five Layer Internet Protocol Stack — DTN Protocol Stack Including Bundle Layer

Figure 2: Protocol Stack of Internet and Delay Tolerant Networks

There can be two sorts of Contacts in DTN. To begin with kind of contacts are opportunistic contact. In this sort of contact the node does not have any sort of immediate or aberrant data with respect to a contact later on. All the contact is an effect of by-chance. Second class of contacts are planned contacts. These sorts of contacts are those in which contact event is already known. This sort of contact for the most part happens when the nodes move along a particular pre-defined way [6,9]. There are few significant routing protocols such as epidemic [10], spray and wait [11], spray and focus [12] ProPHET [13] and Maxprop [14] which are utilized in DTN.

III. RELATED WORK

A significant concern in a system is congestion. A system is called congested if the quantity of messages sent on the system is more prominent than the limit of the system. [1] DTN is a structure of hop-by-hop framework. In DTN, flow control and congestion control are related thoughts. Flow control should be possible by restricting the sending rate of a node to its next bounce node. Congestion Control implies dealing with the buffer at a DTN gateway [8].

The significant techniques present to treat with these concerns are Proactive Control, Reactive Control and Hybrid Control. – The proactive control is known as congestion avoidance and in this the inner primary approach is used prior to the happening of congestion. A node can choose whether to acknowledge or dismiss the custody of another package in view of its present buffer condition.

Reactive control technique reacts when congestion happens in the system. Hybrid control technique performs congestion avoidance and furthermore responds to congestion development if it occurs in the system. As of now said in customary web the Transmission Control Protocol (TCP) is in charge of dependable and congestion free correspondence. Yet, in DTN congestion control is a testing assignment on the grounds that in DTN end to end way amongst source and goal can not be ensured dependably and correspondence latencies can be discretionarily long. Because of this it makes high engendering delay. It stores the message in its buffer for quite a while. It might be in hours or days. Congestion can be controlled by diminishing the sending rate in a system. Congested node drops the bundles to manage blockage. On the off chance that dropping rate is speedier than the sending rate then huge measure of bundles can be dropped. These messages may have been sent through numerous past hops and consume extensive system assets before at last being dropped. That outcomes information can be retransmit which can diminish system performance. Research in DTN exchange dependability and blockage control is still in its beginning time [15]. Parcel of work in past has just been done to control blockage in DTN. The writers in the past have worked in the field of blockage on the premise of two methodologies i.e. Reactive and Proactive. In Reactive approach three vital inquires about are AFNER, N-Drop and DATM.

Average Forwarding Number for Epidemic Routing (AFNER). This congestion control is a reactive technique. It chips away at the supposition that the sending bundles are non-divided. Message bundles are organized in rising order of their sending numbers. The message achieves its goal when the sending number of bundle is more prominent than the normal sending number of the parcel is more noteworthy than Average Forwarding Number of the parcels living in the entire buffer [16]. **N-Drop** Congestion control is a reactive technique in light of the data which is put away inside the node. In the event that the node is skilled to store the message to be sent in its buffer, it stores them generally checks for congestion and store the bundle by deleting as of now put away packets on contrasting and the threshold value (N). In the event that there are no such parcels whose sending number isn't more noteworthy than the threshold (N), at that point the last got bundle in the buffer will be deleted [17]. **DATM –** To tackle the blockage issue in opportunistic system, a congestion control procedure is suggested that depends on message deleting and transferring (DATM). The moving of the node in opportunistic system isn't irregular however constrained by time and space. In this way, a few nodes have high experience probability with the goal node. DATM is an arrangement of calculations summoned at a opportunistic system when congestion happen. The congested node finds a message for goal and another message for movement. In the interim the neighboring nodes decide if to get the exchange message and offer reaction to the congested node. On the off chance that the neighboring nodes decline to get the exchanged message it will be erased [18].

In Proactive technique two foremost researches are TBCC and CASE. **Token based congestion control** (TBCC) is a congestion avoidance technique which is a proactive approach. In this approach those nodes which have substantial tokens can infuse or send the messages. The principle point of the TBCC is to coordinate the amount of information entering in the system with the aggregate system limit which implies that any system or node must get that quite a bit of information as much as it can convey [19]. Congestion Avoiding Strategic Epidemic Routing (CASE) is a blockage avoiding strategic epidemic routing algorithm. Epidemic is generally utilized and reached out because of its elite highlights, yet there is a reasonable possibility of imparting node being congested and high message drop [20].

IV. PROPOSED WORK

In any network, dispersing packets during correspondence is a vital matter that needs attention, likewise in DTN the problem of congestion, pertaining to packet falls or messages receiving deleted, is as vital concern as, creating the connection among nodes where end to end connection is not assured. In DTN the normal latency of the network and normal hop tally are equally fixed and each has some fix value. Our proposed framework for network congestion is based on congestion avoidance approach (proactive). Our research mainly focuses on buffer management policy. The buffer management policy normally cannot noticeably decrease the network overhead so we develop the new dropping policy which is based on size of the message and TTL of the message. As per our proposed framework a threshold value for buffer occupancy is establish and all the incoming message are accommodated in the node's buffer normally until the threshold value is attained. When the space of the buffer comes near to the threshold value our proposed framework becomes active. As per our proposed framework when a new message comes, size of the incoming message is calculated. Messages having largest size from the incoming packet in the buffer node are recognized and selected. After that the Time to Live (TTL) value is obtained for selected messages. A comparison of the TTL value of the incoming message and selected message is performed. If any message in selected message has lower TTL value than the TTL value of the incoming message, the message with lower TTL will be dropped otherwise the incoming message cannot be accommodated in the node's buffer.

V. EXPERIMENTAL RESULTS

In order to executive the proposed idea there are some system prerequisites. The system should support Java based integrated opportunistic network environment (ONE) simulator, which is a extremely recommended for performing DTN related research simulation and monitor the enviable results. We are using Java Net Beans with ONE Simulator setup.

There are few classic performance metrics for examining the work of DTN protocols such as delivery probability, over head ratio, buffer average time etc.

$$\text{Delivery Probability} = \frac{\text{No. of messages delivered to the destination}}{\text{No. of messages sent by the sender}}$$

$$\text{Overhead Ratio} = \frac{\text{No. of relay messages} - \text{No. of delivered messages}}{\text{No. of delivered messages}}$$

 ISBN: 978-93-86171-74-0

Buffer Average Time is the time that message spends in the node's buffer. To examine the percentage span of enhancement in the performance of considered routing protocol (epidemic) by dropping the messages from the node's buffer we have worked out a simulation setup. The featured simulation arguments for the considered scenario are described in the table below:

Table 1: Simulation parameter

Parameters	Value
Simulation Time	43200 s
No. of Host group	1
No. of Host per group	100
Buffer size	4m-30m
Movement Model	ShortestPathMapBasedMovement
Worldsize	4500, 3400
Group router	Epidemic
Event.hosts	0, 99

The results obtained from our experiment with 100 nodes are summarized below in the Tables and figures:

Table 2. Comparison of Delivery Probability

	Delivery Probability		
Buffer size	**Normal Behavior**	**Proposed Behavior**	**Percentage**
4 MB	0.0995	0.0903	9.25
8 MB	0.1626	0.1779	9.41
12 MB	0.2154	0.2482	15.23
16 MB	0.2621	0.3041	16.02
20 MB	0.3303	0.3441	4.18
24 MB	0.3554	0.3728	4.90
30 MB	0.4123	0.4021	2.50

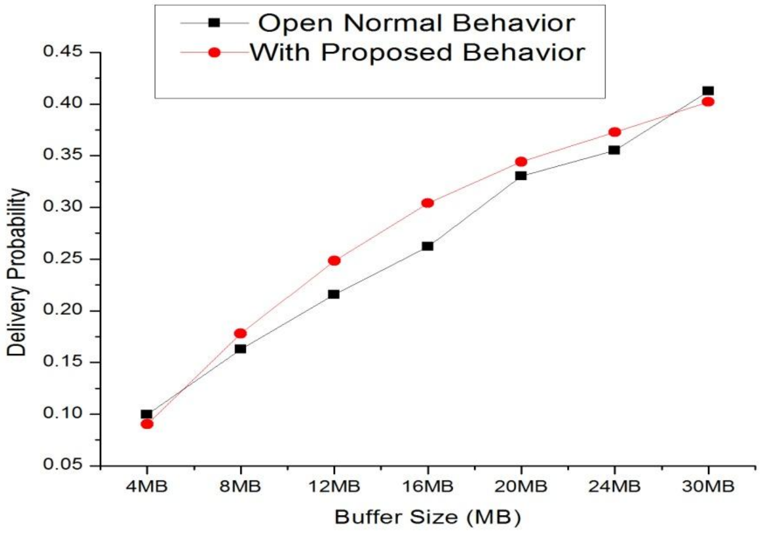

Figure 3. Comparison of Delivery Probability

From the data of Table 2 and Figure 3 it is concluded that the delivery probability of the nodes increases from 3% to 16% with different buffer sizes when our proposed buffer management mechanism is implemented. The maximum increase in the delivery probability is observed at 16Mb buffer size and this increase is about 16%.

Table 3. Comparison of Overhead Ratio

	Overhead Ratio		
Buffer size	**Normal Behavior**	**Proposed Behavior**	**Percentage**
4 MB	97.0928	120.6080	24.22
8 MB	103.0442	125.3977	21.69
12 MB	90.2833	114.4401	26.76
16 MB	79.8160	97.1349	21.70
20 MB	65.8152	85.5931	30.05
24 MB	61.2179	77.2737	26.23
30 MB	55.1418	68.6378	24.48

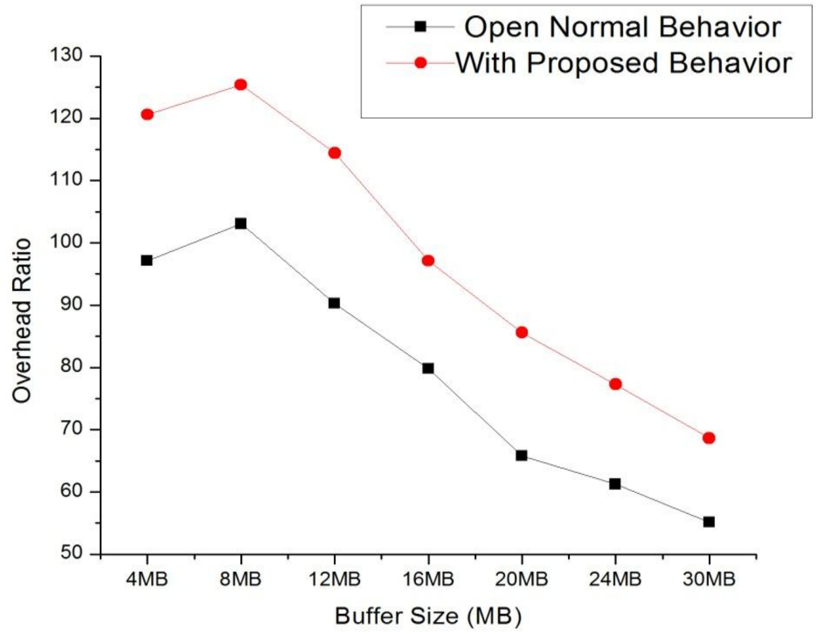

Figure 4. Comparison of Overhead Ratio

From the facts and figures mentioned in Table 3 and Figure 4, is can be analyzed that the overhead ratio of the proposed mechanism is high as compared to the Normal behavior. But this increase in the overhead ratio is at the cost of increased delivery probability in case of our proposed mechanism. There is increase in overhead ratio as our mechanism removes the messages with larger size and less probability/time to get delivered and make space for the new incoming message which has higher chances of being delivered.

Table 4. Comparison of Buffer Time Average

	Buffer Time Average		
Buffer size	**Normal Behavior**	**Proposed Behavior**	**Percentage**
4 MB	840.1613	673.2940	19.86
8 MB	915.9741	729.3203	20.38
12 MB	1038.3159	879.8871	15.31
16 MB	1205.2419	1056.7311	26.76
20 MB	1379.2509	1213.3062	12.03
24 MB	1542.6765	1362.0041	11.71
30 MB	1754.3405	1549.5800	11.67

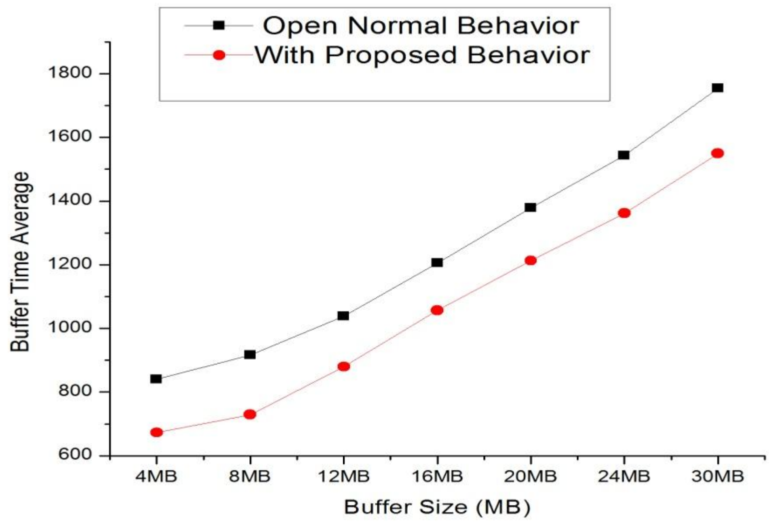

Figure 5. Comparison of Buffer Time Average

From the results obtained and depicted in Table 4 and Figure 5, it is evident that with the new proposed buffer management mechanism, the messages are now being delivered more quickly and staying for less time in buffer of the nodes. This means that the buffer is being now relaxed for accommodating the new incoming messages and hence contributes in higher delivery probability.

VI. CONCLUSION

In this paper we proposed a new congestion avoidance framework so as to prevent congestion in the node buffer. In this technique to solve the problem of congestion we used the size and TTL of the message. We have conducted an experiment by using the ONE Simulator with epidemic protocol and shortest-path-map-based movement model. Simulation results show that delivery probability has improved. The enhancement in delivery probability has been seen up to 16 percent. The simulation results also show that to accommodate a new message when an old message is dropped the overhead ratio increased which is natural. Buffer time average has slow fallen down when the proposed framework became active.

In future we will expand our proposed framework on different routing protocols and also on different movement models to avoid the congestion in node's buffer.

REFERENCES

1. Forouzan, A Bechrouz, "Data Communications and Networking. Tata McGraw Hill, New Delhi, 2012.
2. K. Fall, S. Fareell, "DTN: An Architectural Retrospective. *IEEE Journal on Selected Areas in Communications.* Vol. 26. No. 5 June 2008.
3. M. Loubser, "Delay Tolerant Networking for Sensor Networks," SICS Technical Report, ISSN 1100-3154, January 2006.
4. Z. Zhang, "Routing in Intermittently Connected Mobile Ad Hoc Networks and Delay Tolerant Networks: Overview and Challenges", IEEE Communications Surveys and Tutorials, Vol. 8, Issue No. 1, pp. 24-37, January 2006.

5. Z. Zhang and Q. Zhang, "Delay/Disruption Tolerant Mobile Ad Hoc Networks: Latest Developments," Wiley InterScience, Wireless Communications and Mobile Computing, pp. 1219-1232, 2007.
6. V. Cerf, S. Burleigh, A. Hooke, L. Torgerson, R. Durst, K. Scott, E. Travis and H. Weiss, "Interplanetary Internet (IPN): Architectural Definition," Available Online: https://tools.ietf.org/html/draft-irtf-ipnrg-arch-00 *Accessed as on 03/06/2015*.
7. V. Cerf, S. Burleigh, A. Hook, L. Torgerson, R. Dust, K. Scott, K. Fall and H. Weiss, "Delay-Tolerant Networking Architecture," IETF Network Working Group, RFC4838, Informational, http://www.ietf.org/rfc/rfc4838.txt, April 2007. *accessed as on 04/06/2015.*
8. I. Psaras, N.Wang and R. Tafazolli, "Six Years Since First DTN Papers: Is There A Clear Target?" First Extreme Workshop on Communications, Laponia, Sweeden, 2009.
9. K. Fall, "A Delay-Tolerant Network Architecture for Challenged Internets," Intel Research Berkley, 2003.
10. Lindgren, A., Doria, A., Schelén, O.: Probabilistic routing in intermittently connected networks. SIGMOBILE Mob. Comput. Commun. Rev. **7**, 19–20 (2003)
11. Spyropoulos, T., Psounis, K., Raghavendra, C.S.: Spray and wait: an efficient routing scheme for intermittently connected mobile networks. In: Proceedings of ACM SIGCOMM workshop on Delay-tolerant networking (WDTN '05), pp. 252–259. ACM, New York, Philadelphia, PA (2005).
12. Spyropoulos, Thrasyvoulos., Psounis, Konstantinos & Raghavendra, Cauligi S., "Spray and Focus Efficient Mobility-Assisted Routing for heterogeneous and Correlated Mobility" IEEE 5th Annual International conference on Pervasive Computing and Communications workshop, 2007.
13. Lindgren, A., Doria, A., Schelén, O.: Probabilistic routing in intermittently connected networks. SIGMOBILE Mobible Comput. Commun. Rev. **7**, 19–20 (2003)
14. Burgess, J., Gallagher, B., Jensen, D., Levine, B.N.: MaxProp: routing for vehicle-based disruption-tolerant networks. In: Proceedings of IEEE INFOCOM, Barcelona (2006)
15. G. Zhang, Y. Liu, "Congestion Management in Delay Tolerant Networks", Proc, 4th Annual International Conference on Wireless Internet Brussels, Belguim, 2008.
16. Li Yun, Cheng Xinjian, Liu Qilie and You Xiaohu, "A novel congestion control strategy in Delay Tolerant Networks, "Future Networks Second International Conference, Sanya, Hainan, 2010.
17. Li Yun, Cheng Xinjian, Liu Qilie and You Xiaohu, "N-Drop: Congestion Control Strategy under Epidemic routing in DTN, Wireless Communication and Mobile computing: Connecting the world wirelessly conference on IWCMC, Leipzig, Germany, 2009.
18. Patil, Peeyush and Penurkar, Milind, "Congestion Control in DTN", Fourth Post Graduate Conference, SPPU Pune, 2015.
19. Coe E and Raghuvendra C, "Token based Congestion Control for DTNs, "Aerospace conference, Big Sky, MT, USA, IEEE 2010.
20. Soelistijanto, Bambang and Howarth, Michael P, "Transfer Reliability and Congestion Control Strategies in Opportunistic Networks: A Survey. IEEE Communications Surveys and Tutorials, Vol. 16, pp. 538-555, 2013.