Spray and Wait Protocol based on Prophet with Dynamic Buffer Management in Delay Tolerant Network

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Abstract- Delay tolerant network is a challenged network where end-to-end connectivity does not exits.DTN are characterized by intermittent connectivity, high error rate and long delivery time. Routing is a major issue in Delay tolerant network. In order to route the information efficiently in such an environment researcher have proposed various classes of routing protocol. In this paper we studied three routing protocols namely epidemic, PRoPHET and Spray and Wait routing. When we consider routing protocols of DTNs, the buffer management scheme and forwarding decision are important to improve the opportunity of successful message delivery. In this paper, we propose improved Spray and Wait routing based on the delivery probability with dynamic buffer management to reduce irrelevant overhead to the node.

Keywords- *DTN, Epidemic, PRoPHET, Spray and Wait, Buffer management*

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I. INTRODUCTION

In today's world, Due to internet many of devices (computers, Mobiles) are communicating with each other in all around the world. For the humans better and easy life the technologies are increasing everyday communications so networks are emerging that are different and more Massive. The networks have given new opportunities for the different types of applications. There are number of networks used in connecting and communicating with different devices and it is only possible by some set of protocols known as TCP/IP protocol suite.TCP/IP is based on end-to end data transfer. However, the assumptions of the internet cannot be satisfied in many regions. If there is no path between the sources to destination, then TCP/IP fails to work. Because of such circumstances, a newer network has evolved which is independent end to end connectivity between nodes. This network is called as Delay Tolerant Networks (DTN) [1].

DTN refer to a wide range of challenged networks, where 1) End-to-End connectivity does not exists. 2) Partitioning of Network is frequent.3) Delay can be tolerated. The DTN examples are Inter-Planet satellite communication network, Military battlefield network, Wildlife tracking sensor network and underwater wireless sensor networks.

DTN routing usually follows store-carry-and forward; i.e., after receiving some packets, a node stores and carries them around until it contacts another node and then forwards the packets.

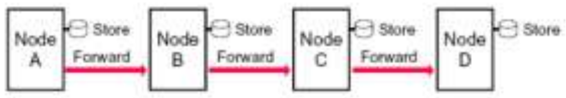

Fig.1 Store and Carry approach

Since DTN routing relies on mobile nodes to forward packets for each other, the routing performance (e.g., the number of packets delivered to their destinations) depends on whether the nodes come in contact with each other or not. A new layer introduces in DTN Architecture named "bundle layer". Bundle layer establish between the transport layer and application layer. Bundle layer store the bundles/packets/messages and forward them.

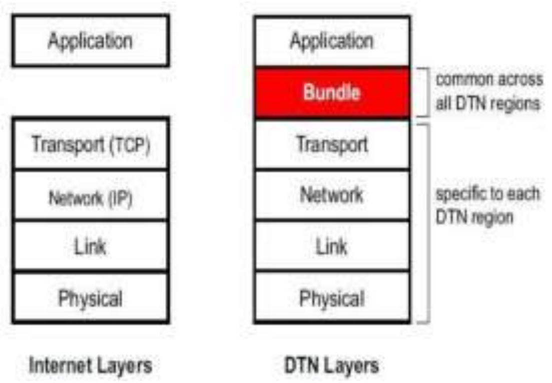

Fig.2 Internet layers and DTN layers [2]

Considering these factors, several routing protocols have already been proposed to address the inherent characteristics of Delay tolerant network. Epidemic routing exchanges random pair-wise messages between nodes that have contact with each other [3]. Yet, despite its good performance, the overhead of flooding-based messages wastes network resources. Furthermore, Epidemic routing creates significant contentions and a communication overhead. Alternatively, Probabilistic Routing Protocol using History Encounters and Transitivity (PRoPHET) is an estimation-based forwarding scheme that uses of contact probability [4]. PRoPHET improves the routing performance by adopting a probabilistic scheme that reflects the contact observation of nodes. However, the single copy forwarding in this probabilistic scheme affects the performance by limiting the initial probability distribution or even dropping the message. Thus, owing to limited buffer space, an efficient buffer management mechanism needs to be investigated to further enhance the performance. Meanwhile, Spray-and-Wait significantly reduces the overhead of flooding-based schemes [5]. Although Spray and-Wait overcomes the shortcomings of the Epidemic routing protocol, the usability of the wait phase with an efficient single copy forwarding scheme and the optimal decision of an initial spray number are still issues to be resolved.

In summary, none of these previous schemes consider the buffer management mechanism of each node. Accordingly, since a forwarding decision and dynamic buffer management scheme are critical for improving successful message delivery. In this paper, we propose a Spray-and Wait based on probability scheme that utilizes the concept of probability-based message delivery in the spray phase of the original Spray-and Wait. The proposed scheme also considers the dynamic buffer management policy.

This paper is organized as follows: - Section II discusses related work. Section III presents proposed method. In Section IV concludes the paper followed by future work.

II. RELATED WORK

A. *Epidemic*

The Epidemic routing was proposed to provide packet delivery in disconnected network. Because there is no guaranteed existing route for communicating pairs, the effort to find a route is not carried out any more. Instead, buffering the packet and waiting for opportunities to meet the destination is the essential strategy for the epidemic routing. Moreover, in order to increase the probability of a packet to meet its destination, letting other intermediate nodes carry a copy of this packet is a second measure carried out by epidemic routing. This packet copy dissemination is achieved during the movement of the node carriers by exchanging the summary vectors between two meeting nodes. For the summary vector, each node will keep records of the received packets within itself in the form of a table. Generally, this table is indexed with the packet ID which is unique in the network. Then, the binary value corresponding to each packet ID entry in the table represents whether the packet with this ID has been received by this node: 1 for received and 0 for not received. Therefore, the summary vector is used to receive new packets and avoid receiving the same packet for a node when it meets a new neighbour. When a new neighbour comes into contact, the node with smaller ID will start the summary vector exchange. The node having received the summary vector from its new neighbour will compare this summary vector with its own one to determine which packets for the new neighbour are needed and which packets for itself are needed. Then it will send the packets that its neighbour needs to its neighbour and request the packets it needs from its neighbor. Fig. 1 shows this summary vector exchange. By performing this routine, the packet and its copies can be disseminated to all the nodes

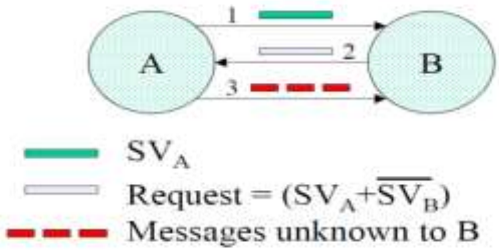

Fig.3 Summary vector exchange in epidemic routing.

B. *PRoPHET*

The Probabilistic Routing Protocol using History of Encounters and Transitivity (PRoPHET) establishes a summary vector that indicates what messages a node is carrying. It also establishes a probabilistic metric called delivery predictability, $P(a,b)\in[0,1]$, at every node a for each known destination b. This indicates how likely it is that this node will be able to deliver a message to that destination. The calculation of the delivery predictabilities has three parts.

First, whenever a node is encountered, the metric is updated as in Eq.1, where *Pini* is an initialization constant

$$P(a,b)=P(a,b)_{old}+(1-P(a,b)_{old})\times P_{ini} \quad (1)$$

Second, if a pair of nodes do not encounter each other after a period of time, they are less likely to be good forwarders of the messages to each other, thus the delivery predictability value must age. Eq.2 shows the aging equation, where $\gamma\in[0.1]$ is the aging constant, and k is the number of time units that have elapsed since the last time the metric was aged.

$$P(a,b) = P(a,b)_{old}\times \gamma^k \quad (2)$$

Third, the delivery predictability also has a transitive property that is based on the observation that if node A frequently encounters node B, and node B frequently

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1034 – 1037

encounters node C, then node C is probably a good node to forward messages destined for node A. Eq.3 shows how this transitivity affects the delivery predictability, where β is a scaling constant that decides how much the impact the transitivity should have on the delivery predictability.

$$P(a,c)=P(a,c)_{old}+(1-P(a,c)_{old})\times P(a,b)\times P(b,c)\times \beta \quad (3)$$

C. *Spray and Wait*

Spray and wait manages to significantly reduce the transmission overhead of epidemic routing and has better performance with respect to delivery delay in most scenarios Spray and wait allows a source node to initially generate *L* number of copies of a message. The scheme makes use of two phases, the spray phase and the wait phase. During the spray phase, the source node forwards *L* copies of a message to *L* nodes which do not have a copy of the message. If the destination is not among these *L* nodes, then the scheme switches to the wait phase where the *L* nodes keep their copy of the message until the destination is reached. Once meet, the message is delivered to the destination directly.

Binary spray and wait [6] improves spray and wait. The difference is in the spray phase. A node forwards half the copies of a message until it has more than one copy of that particular message for a node that does not possess a copy of that message. When a node is left with only a single copy of a message, it switches to the wait phase and performs direct transmission when it meets the destination.

III. PROPOSED METHOD

In order to enhance the data delivery ratio in the DTN environment where a node's movement cannot be predicted, this paper proposes the spray and waits protocol based on PRoPHET. In this section, we propose a Spray-and Wait based on PRoPHET scheme that provides the concept of probability-based message delivery to the spray and wait phases of the original Spray-and-Wait strategy. The proposed scheme also considers the dynamic buffer management policy. Conventional Spray-and-Wait routing can be divided into two phases: the spray phase and the wait phase. In the spray phase, a node replicates a copy of a message and forwards it to other nodes. Meanwhile, in the wait phase, the nodes that carry the message (stored in their buffer) move around and wait until they encounter a destination node. A node that encounters a destination node then delivers the message to its destination. Hence, messages are sprayed without using any information in the spray phase of the Spray-and-Wait routing protocol, which causes meaningless duplications. In an actual environment with a fixed buffer size, this can cause message losses due to buffer overflow. Buffer waste can be reduced and the message delivery ratio increased if messages are copied to nodes with a high probability of data delivery in the spray phase.

i. *Spray phase*

A method is proposed that copies messages to a node with a high probability of data delivery. The data delivery probability is the same as that used in the PRoPHET routing protocol. Figure 1 shows the operation of the spray phase.

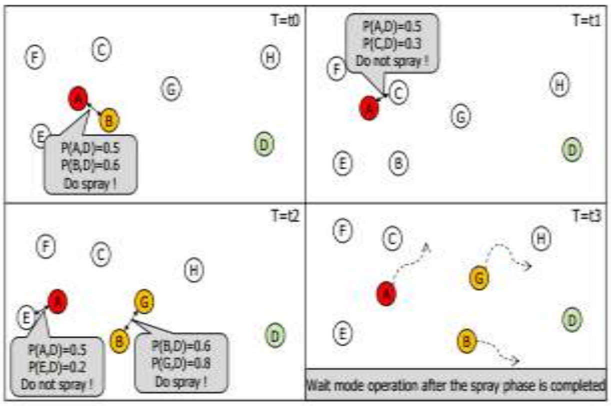

Fig 3. Spray phase

At *T=t0*, source node A generates *L* copies of a message. At *T=t1*, source node A encounters node B during movement. The two nodes exchange the data delivery probability for all their nodes and update their results. At *T=t2*, node A hands the message with the *LB* calculated according to over to node B, as the data delivery probability of node B is higher than that of node A. Note that at *T=t1*, if node A encounters node C during movement, the two nodes exchange the data delivery probability and update their results as before. However, node A does not hand the message over to node C because the delivery probability of node C is lower than that of node A. All nodes that have an *L* of more than one operate in such a way until *L* equals one.

$$L_B = \left\lfloor L_A\left(\frac{P(B,D)}{P(B,D)+P(A,D)}\right)\right\rfloor$$

LA is the number of message copies residing in node A; *P(B,D)* is the data delivery probability between nodes B and D, and *P(A,D)* is the data delivery probability between nodes A and D.

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1034 – 1037

ii. *Wait phase*

After the spray phase is complete ($L = 1$), a node moves on to the next step. Figure 2 shows the operation of the wait phase. At *T=t0*, node A and node B are in the wait phase because the value of *L* is one. At *T=t1*, node B encounters node C during movement, and, the two nodes exchange the data delivery probability for all their nodes and update their results. Node B delivers the message to node C because the message delivery probability of node C is higher than that of node B. At *T=t2*, node C, which has received the message from node B operates in the wait phase. When node C encounters node E during movement, the two nodes exchange the message delivery probability in the same way as before. However, node C does not deliver the message to node E, as the delivery probability of node E is lower than that of node C.

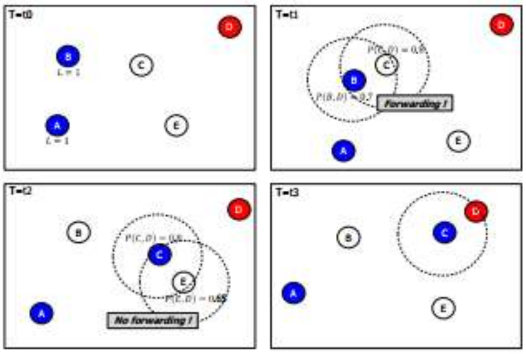

Fig 4. Wait phase

iii. Dynamic Buffer management policy

In addition to a routing protocol, an efficient buffer management strategy is critical for DTN operations. If a node's buffer is overloaded, previously stored messages are dropped, as the node cannot accommodate all the incoming messages. When a node receives a message from an encountered node, the node compares the remaining buffer space to the size of the received message. If the remaining buffer size is greater than that of the received message, the node stores the message in the buffer. To increase the packet delivery ratio of spray and wait routing protocol we are introducing an acknowledgement scheme with dynamic bundle size. In spray and wait routing protocol the buffer size is fixed but if we set the buffer size dynamically then we can increase delivery probability of a bundle. Working of proposed protocol is as follows, On receiving Buffer size request packet , the node sends back Buffer size acknowledgement packet specifying the packet size. After this agreement source node will initiate data transmission. This process will repeat for every hop to hop transmission.

Consider an example shown in the figure 5 if the source S wants to send a data to destination D, it will first ask the buffer capacity of destination node as it is unaware of its buffer size. So the source S will send Buffer size request packet to neighbouring node A , the node A will send the required buffer capacity (10kb) to node S using Buffer size acknowledgement packet. Then source node S will send bundle of size specified in Buffer size acknowledgement packet (10kb).

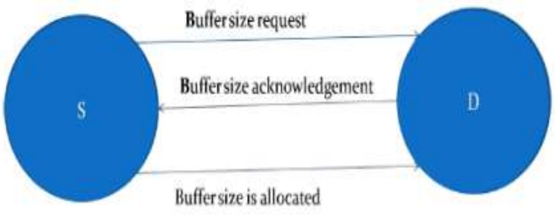

Fig 5. Dynamic buffer management

IV. CONCLUSION AND FUTURE WORK

The challenging issue in DTN is to route the data in opportunistic connected network. Proposed routing protocol avoids useless Spray in the conventional Spray and Wait routing protocol, the Prophet routing protocol is used because of delivery probability. Thus efficient message delivery is obtained by only spraying message copies to the nodes with a higher probability of message In future work security to the data can be provided.

REFERENCES

[1] Kevin Fall, "A Delay-Tolerant Network Architecture for Challenged Internets" SIGCOMM'03, August 25-29, 2003, Karlsruhe, Germany. Copyright 2003 ACM

[2] Maurice J. Khabbaz, Chadi M. Assi,andWissam F. Fawaz, "Disruption-Tolerant Networking: A Comprehensive Survey on Recent Developments and Persisting Challenges" IEEE 2012.

[3] A. Vahdat and D. Becker, Epidemic routing for partially-connected adhoc networks, Technical Report CS 2000-06,Duke University, 2000. [4] A. lindgren, A. Doria, and O. Schelen, "Probabilistic routing in intermittently connected networks," ACM SIGMOBILE Mobile Comp. and Commun. Review., vol. 7, no. 3 pp. 19-20, July 2003

[4] T. Spyropoulos, K. Psounis, and C. S. Raghavendra, "Spray and wait : an efficient routing scheme for intermittently connected mobile networks," In Proceedings of ACM Workshop on Delay Tolerant networking (WDTN), Philadelphia, PA, USA pp. 239-254, August 2005.

[5] D. Johnson and D. Maltz, "Dynamic source routing in adhoc wireless networks", Mobile Computing, Kluwer Academic Publishers, Dordrecht, The Netherlands, 1996