Routing based Protocols in Delay Tolerant Networks: Survey Study

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Abstract— Routing is a critical issue and challenging scenario in delay tolerant network, as these networks are primarily effected by long delay transmission and high error rates. In order to understand these challenges and performance parameters of networks a rigorous survey is carried out in this paper with different routing protocols. The strategies and issues employed in routing protocols are widely discussed in terms of latency, data delivery and packet loss. The major problems addressed in the work deals with routing a packet from one node to the other using DTN.

The major considerations of the network are discussed in form of a novel approach to show the improvements in routing the data by matching the literature through an optimal scheme. Routing in DTN uses a bundle protocol with specifications for information dissemination of data and message. The dependent factors of DTN routing are node history, predicting and estimating the node contact, mobility, availability of network resources. The work reveals in three different topics one such topic is intermittently routing the data through DTN, secondly improvements based on the literature, lastly ordering of the packets with protocol specifications.

Different topologies characterized with DTN design are also discussed using store and forward mechanism in transmitting messages from source to destination. The theme of this work is to highlight the features of DTN, comparison with various routing protocols, issues, techniques and its applications.

Keywords— DTN, Routing protocols, latency, bundle

I. INTRODUCTION

Emergency applications use opportunistic network for routing data from source to destination [1]. This network use both fixed and mobile nodes in transmitting data from one node to other. Usually the difference between traditional networks and opportunistic network is the that a traditional method has advanced data forwarding path between the nodes but in opportunistic network end to end path is not defined in advanced as this nodes are mobile in nature. Oppnet is used to form a network with a group of nodes connected together [2]. These nodes complete the task with tolerant delay. The evaluation of the network is carried out on basis of resource availability and usability of each other nodes. The devices are routed to complete the task assigned using added nodes and the data is exchanged between source and destination [3].
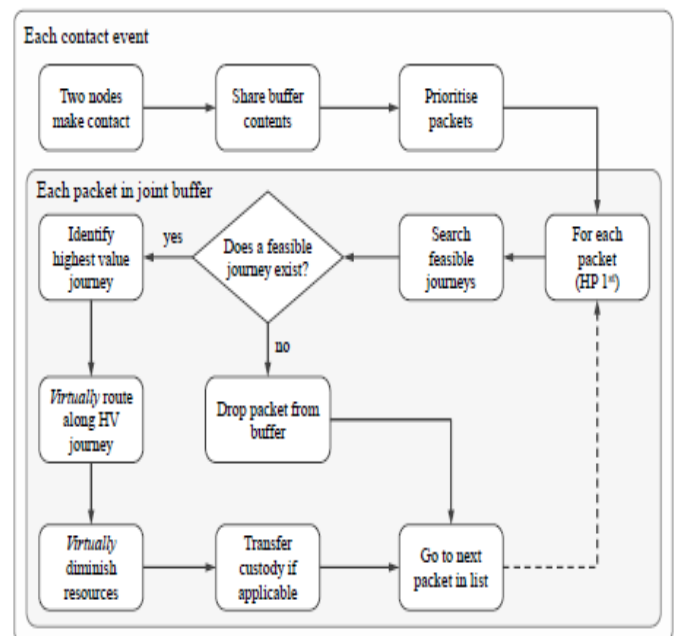

Figure 1: shows the routing process from one node to other

The knowledge and path determines the routing decision in sending the message from one node to the other [4]. The messages are stored and forwarded based on the opportunity and routing decision.
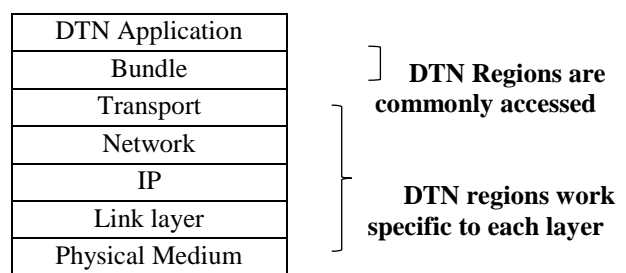

Figure 2: shows the DTN architecture for TCP/IP layers of OSI model

Every DTN protocol has an edge network built with application layer protocol using store and forward approach [5]. The bundle protocol is a convergence layer used as TCPCL. The internet model protocol drawn under the network is shown below in figure 2
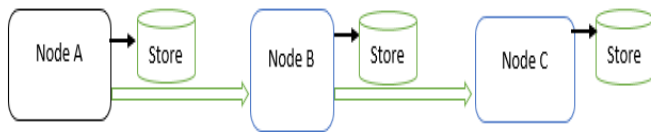

Figure 3: the operation of store and forward mechanism of DTN

The end to end connection for source and destination are established with different partitions for each regions. The network enables as store and forward mechanism while transmitting messages as shown in figure 3. Here DTN uses a new layer called bundle which can act as host (router or gateway) to store and carry forward the bundles of fragments in same region between end to end nodes. Different regions can support each other using a gateway [6].

The end to end path from source to destination is not fixed in wireless network as delay tolerant network has frequent disconnections which is as shown in figure 2. Assume two nodes are in contact with each other whenever there is no communication between them, it means that opportunity is established. During this the nodes are established to contact with each other.
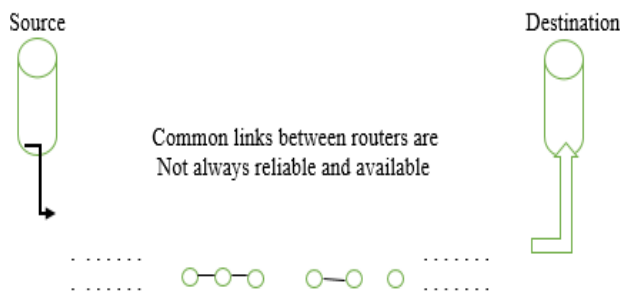

Figure 4: shows the major routing problem in delay tolerant network

Routing protocols use temporal path to exchange data between nodes but there is no means of guarantee in end to end path. These protocols are applied to reduce the delay and network overhead with increased end to end delay path as shown in figure 4. The nodes use store and carry forward approach to encounter the value with a record. The buffer is used for temporary storage with encounter value record where the higher value has more chances of message delivery with no overhead ratio. The encounter based routing protocol has variation with respect to time for long term message storage. The message dropping policy is an efficient approach in passing the data between the nodes. They also use traditional LIFO and FIFO policy [7].

This work basically introduces the following sections, in the section 1 Introduction and overview of the work is identified and the section 2 defines the literature survey and various protocols used in buffer management, latency and end to end path. Section 3 describes the best protocol identified in opportunistic network. The section 4 presents conclusion and summary.

II. RELATED WORKS

This section describes the basic background of routing based protocols with a brief replication. The major challenges and its issues related to energy aspects and performance metrics are discussed in the below subsections

2.1. Review on Routing protocols and their families:

Delay tolerant network (DTN) have major challenges in routing approaches from one end to other end. The node connections are static and fixed due to intermittent connectivity and end to end path. The pair connections between each nodes are discussed in brief for various dynamic network topologies [12].

2.1.1. Epidemic Routing based protocols:

This routing is based on spreading the contact in connection to different nodes just like an infectious diseases affected among people. The routing defines exchanging the messages with initiated session ID of two different points [10]. The node maintains a summary of the vector details such as message count, identifier, average hops, acknowledgement, delivery ratio, latency, cost and efficiency [6]. This protocol transmits messages in to many copies and sent in flooded manner throughout the network for better usage of resource bandwidth and buffer occupancy. The messages are carry forwards the encountered message to avoid the wastage of resources and replications delivered to the destinations with acknowledgements. Hence the recovery scheme used to delete the unnecessary network after the time expires it works in efficient manner. This algorithm also has VACCINE which helps in deleting messages and free up buffers. Here there is also a policy where the incoming messages are filled in the buffer where the newly upcoming message drops the message using FCFS policy [4].

2.1.2. Probabilistic routing protocol using history of encounters and transitivity (PROPHET)

This protocol use probabilistic and estimated approach to keep track the node delivery mechanism. Hence the node estimates the DTN packet carrier for each encountered message packet. Here the source node is flooded with messages and each node has p value which decides the probability. This messages are estimated based on the history and previous contact for the given network. On contrary epidemic routing forwards the message copies to all but PROPHET use probabilistic mechanism to forward messages only to higher delivery nodes and effectively utilizes resources of network such as buffer and bandwidth [12]. In this algorithm the effective utilization of resource is carried out with guarantee in delivering the data and also able to calculate probabilities estimated. The training is much required in this algorithm for effective result in forwarding the delivery data [18]. Further to this the networking information and amount of time taken in decisions are

recorded to find the delivery ratio. As the buffer is full the messages arrived are dropped out using FCFS scheme.

2.1.3. Spray and wait routing protocol

The major use of this protocol is to effectively utilize resource and also reduce the consumption rate of resources. It also focusses on the distribution of the messages in the network. On comparison with traditional routing protocols the resources are not wasted and there is much control to the messages distribution. This protocol do not any knowledge of network, patterns of fixed and mobile during encounter of the network nodes. This protocol significantly reduces the consumption of resource and encounters in few transmissions. The protocol is emphasized in two phases where first one spray is used to forward the copies of messages from source node using L copies and then wait for some time until the confirmation of delivery is provided by network nodes.

The second one is wait phase where the message is not reached from each L nodes and this copies the message for direct transmission.

2.1.4. Encounter based routing: In this protocol the quota is used to replicate the message which has high delivery and optimal energy in delivery of messages of the network. The minimum overhead is carried out by reducing the forward copy of each node for better connectivity [18]. The Encounter routing protocol provides high delivery, prediction based on history and future state of encounter. The source node has high successful rate of achieving probability in data transmission for destination. The nodes are encountered to determine the message replicas in transmission and reception. The encountered value decides the message replicas and defines the interval of time and periodically updates the correct information.

2.1.5. Comparison of DTN routing protocols: To understand these popular protocols a comparison is carried out to evaluate its advantages and disadvantages the protocols used are (1) epidemic[8] (2) Prophet [2] (3) spray and wait [16] (4) Encounter[26] to focus and optimize the delivery ratio.

Table 1: Comparison of DTN routing protocols

Protocol	Advantages	Disadvantages
Epidemic	1. unlimited storage space is assumed 2. Destination obtains the message even if it is delivered	1. Can be used only in sparse network 2. Able to deliver very small size messages
PROPHET	1. Lower space required for buffer 2.better performance and reliability when compared with epidemic	1. Need history of encounters 2. Communication requires transitivity
Spray and wait	1. can retain the copies of the messages 2. wait phase can transmit only to the destination directly	1. more latency 2. useful for mobile networks in efficient manner but not useful to intermittently connected and adhoc networks
Encounter	1. Store and forward network 2. Low overhead, good latency, high message delivery ratio.	1. constrained buffer space 2. unable to deliver high hop messages

III. PERFORMANCE PARAMETERS IN DTN ROUTING

Delay tolerant network (DTN) uses various performance parameters to satisfy the efficient routing protocol such as latency, cost, and high delivery rate. Here energy is an important aspect in measuring the performance of a communication paradigm. Some of the identified parameters are

3.1. Delivery latency and cost: Latency is a delay of packet measured for time taken to travel from source to destination. The number of message copies are measured in routing protocols based on the schemes employed for a given network.

3.2. Energy, data, coverage measured in terms of efficiency: The number of messages delivered for the energy spent in unit of time. Data efficiency defines the successful delivery of packets in single cast to multicast schemes for the traffic generated in the network. The coverage efficiency defines the percentage of message holding and delivered from time to live and remains left until it expires.

IV.CONCLUSION

The opportunistic networks performance is mostly affected by an aspect known as Energy. Among the protocols discussed the epidemic routing protocol achieves better performance with high energy consumption. This work defines the pros and cons of various algorithms defined where encounter based routing provides faster message delivery, end to end path. Similarly the PROPHET algorithm provides effective resource management with minimum overhead ratio. The FCFS policy drops the packet as the buffer is full. This improves the performance parameters in terms of security, efficiency, buffer size and timely management of tasks. The source to destination nodes use n and p values for estimating and reducing the energy consumption. In order to measure the performance parameters the node density and energy consumption. Whenever the resources utilization is reduced the network life time is increased effectively. The routing protocols major challenges are delivery ratio, latency, cost and minimum overhead. Delay tolerant network (DTN) is a dynamic paradigm to explore the modern network design with mobile devices. The brief overview of different routing protocols are investigated in the survey.

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