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Routing in Delay Tolerant Network: A Survey

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Abstract—Routing in delay-tolerant networking concerns itself with the ability to transport, or route, data from a source to a destination, which is a essential ability all communication networks must have. Delay tolerant networks (DTNs) are categorized by their absence of connectivity, causing in a absence of sudden end-to-end paths. In these challenging environments, popular ad hoc routing protocols such as AODV and DSR fail to establish routes. This is due to these protocols trying to first create a complete route and then, after the route has been established, forward the real data. However, when instantaneous end-to-end paths are difficult or difficult to establish, routing protocols must take to a "store and forward" approach, where data is incrementally moved and stored throughout the network in hopes that it will ultimately reach its destination. A common procedure used to make best use of the chance of a message being successfully transferred is to duplicate many copies of the message in hopes that one will succeed in reaching its destination. In this paper I have surveyed some of the useful routing protocol in delay tolerant network.

Keywords-routing, protocols, delay tolerant network, disruption-tolerant network, store and forward

I. INTRODUCTION

Delay-tolerant networking (DTN) is an approach to computer network design that seeks to address the technical issues in mixed networks that may lack continuous network connectivity. Difficult conditions obtain, for example, between distant endpoints in deep space; or into and out of disaster areas; or among mobile user passing through uncertain access points; or among sites that need to be kept covert. DTN provides ways of sustaining digital links in such scenarios, where connection paths are usually intermittent, random, or unreliable. Routing protocols in the wireless network is different than in wired network and affected by various factor. Routing can be divided into these two classes as follows:

Pro-active routing

It also called table driven routing. In this type of routing the information about route and position of nodes are predefined and kept in the form of table. Hence the optimal route can be found with minimal delay but require enough resources to keep these tables up to date.

Re-active routing

It is also called on demand routing. In this approach it does not need predefined information about route. This type of technique finds a route on demand by flooding the network with Route Request packets but incur high latency time in route finding. [4]

II. ROUTING PROTOCOLS

Routing protocols have been established for DTN according to the practical scenarios. These protocols can be classified according to the methodology used to find destinations and whether replicas of messages are transmitted or not. Consequently routing protocols can be broadly characterized by:

- Replica based (flooding) protocols
- Knowledge based (store and forward) protocols
- Coding based protocols.

A. Replication based (Flooding) Protocols

Replication based protocols allow for better message delivery ratios than in forwarding-based protocols. These schemes work by making several replicas of the original message or packet. Each node maintains a number of copies of each message and retransmits them upon connection establishment. These protocols are also referred to as flooding based protocols. Using numerous copies increases the possibility of message delivery to the destination. Flooding based approach is resource hungry, unable to cope network congestions and does not scale well. Decision making for the priority of message replication and dropping under constrained environments is a challenging task. Protocols characterized under the replica based family include the direct contact, two hop relay, relay cast, tree based flooding, epidemic routing, maxprop, probabilistic routing, spray and wait, rapid and runes.

Epidemic Routing tries to send message over all the paths in the network and all the nodes can become the carrier. However upon contact with each other nodes exchange only the data they do not have in their memory buffer. This approach does not require information about the network, however requiring large amounts of buffer space, bandwidth and power. Prioritized Epidemic Routing made a slight change to normal epidemic routing imposes priority functions on the data transmission and deletion. MaxProp protocol puts a priority order on the queue of packets. Packets that should be dropped and those that need to be transmitted are then classified in this priority queue. MaxProp maintains an ordered-queue where the ordering is done based on the destinations related with each message. Probabilistic Routing approach works with the probability of a node's contact with another node. The message is delivered to another node only if its probability of having contact with some other node is way above some probability threshold set. The message is forwarded along the highest probability paths. [3] SaW (Spray and Wait) attains resource efficiency by setting a perimeter on the upper bound on the number of copies being duplicated in two distinct phases: the spray and the wait phase. A bound B is attached with the original message that indicates maximum allowable copies. During the spray phase, one copy of the message is delivered to B distinct relays. The relay upon receiving the copy goes holds it and goes into wait phase until it directly comes in contact with the destination. [2]

B. Knowledge based (Store and Forward) Routing Protocols

Location based routing works by assigning coordinates to nodes in the network. A distance function is calculated to know the cost of getting any node in the network. This strategy does not require routing tables and also has less control overhead since only the source; destination and next hop coordinates are required. However closeness in distance does not provide guarantee of any connection establishment and in a rapidly changing environment the coordinates need to be updated rapidly. Examples of it include the location based routing, source routing, per hop routing, per contact routing, hierarchical routing, gradient routing, link metric routing, delay tolerant link state routing.

In Source Routing only the source has to know of the whole network topology. The source determines the path that the datagram would be following. Hence the source has to be intelligent enough to decide upon its closeness to the destination in hops to have a better performance. In per hop routing, the intermediate hop or node decides upon the next hop or node to which the datagram should be forwarded according to the network topology it has gathered. While in per contact routing, an updated routing table is kept. The update is done on each contact. Therefore whenever a datagram is forwarded it is done upon the latest network topology information. However, the updates can create loops in the network. Opportunistic Routing with Window-Aware Replication (ORWAR) is a distributed algorithm based approach that exploits the connectivity knowledge of mobile nodes speed, direction of movement and range to estimate the size of contact window, hence making better

forwarding decisions and minimizing the probability of partially transmitted messages, thus optimizing overall bandwidth.

C. Coding based Routing Protocols

It utilizes different kinds of coding techniques to encrypt data. Each data packet is uniquely encoded by using network coding. Hence the packets leaving the source are generally coded. A node only needs to receive enough packets to decrypt the data, improving the overall delivery rate. Examples include the Estimation based Erasure Coding (EBEC) and Hybrid Erasure coding (HEC). EBEC uses a fixed overhead to generate a large number of message blocks instead of a few copies allowing transmission of only a portion of message to a relay. This ability increases the diversity in routing and effective when combined with estimation based approach. When two nodes come in contact, a copy may or may not be generated in the other node based on its ability of being better or worse in terms of probability of delivering message. HEC combines erasure coding and aggressive forwarding. Aggressive forwarding mechanism itself has key mechanism of sending all packets in a sequential manner during a nodes contact period. If a nodes' battery is dead or node loses mobility, it cannot deliver data to the destination creating a phenomenon normally termed and referred to as 'black hole' information loss problem. [1]

III. CONCLUSION

The DTN architecture is use in the heterogeneous networks that must operate in environments subject to long delays and discontinuous end-to-end connectivity. Now there are various areas which are using DTN architecture like- Interplanetary Internet, sensor networks, MANET and VANET, terrestrial wireless networks, satellite networks with moderate delays and periodic connectivity, and underwater acoustic networks This architecture has some challenges like- storage, delay, disconnection, limited resources, security etc. The current research is based on to further improve this architecture and work upon its challenges.

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