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# A Survey on Comparative Study of Routing Protocol in Delay-Tolerant Networks

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***Abstract*— Delay/Disruption tolerant networking (DTN) is another class of network communication techniques developed to sustain long link delay and frequent link disruption. Lot of work have been done in evaluating the effectiveness and performance of the different type of DTN Protocols when they are applied on different environment (like the environment where we don't have continuous path between source and sink e.g. Village network, interplanetary network (IPN) etc.). In this paper we present a survey on evaluation of Transmission Control Protocol Convergence Layer (TCPCL) for communication and long-delay communication (eg.MaxProp, Epidemics Routing etc.). A comparative study of various Transmission Control Protocol convergence layer has also been carried out.**

**We are also going to present comparison between different kinds of protocol for communication purpose in delay tolerant network.**

## 1. INTRODUCTION[11][12][1]

Delay-tolerant networks have attracted lots of attention in past 12 years and many related interesting application have been experimented and tested including mobile social networks based on human mobility, sensor networks for wildlife tracking and habitat monitoring, vehicular adhoc networks for road safety and commercial application and deep space interplanetary networks. The challenges to be addressed in DTN is large delay for transmissions resulting from either physical link, properties or extended periods of network partitioning, routing capable of operating efficiently with frequently-disconnected, pre-scheduled, or opportunistic link availability, hyper-link error rates making end-to-end reliability difficult, heterogeneous underlying network technologies (including non-IP-based internets)[10,21], and application structure and security mechanisms capable of limiting network access prior to data transmit in an environment where round-trip-time may be very large that can't be handle by our real life TCP/IP protocol suit. In a DTN commonly we don't have continuous connected paths form communication source to destination because of the mobility of the node, wireless propagation effects, sparse node density and other adverse factor. For this kind of communication networks. Old-style routing protocol we are used are unsuccessful to work because they all works on end-to-end paths connectivity. Therefore, a new routing contrivance called store –carry-and-forward was proposed to provide communication. In order to increase message delivery prospect a variety of routing schemes have been proposed such as two-hop relaying, spray and wait, and MaxProp etc.., which aim to reduce the overhead of epidemic routing.

Some of them routing schemes claim to obtain optimal system performance and typically they attempt to achieve short message delivery delay with relatively low transmission cost. But we have a swap between message delivery delay and delivery cost. Commonly shorter delivery delay is obtained at outlay of higher cost and vice versa. Therefore it is disapprovingly important to accurately evaluate these routing schemes in order to show their advantages and drawbacks objectively

Earlier the technology began to sustain the significant delays and packet corruption of space travel. Initially these projects looked only short-range communication between manned missions to the moon and back, but the field quickly expended into an entire sub-field of DTNs that created the technological advances to allow for the interplanetary internet. Then the concept of DTN is implemented in other area like LEO satellites [periodic connectivity] , Sensor Network connected via "mules" , Roaming underwater vehicles using acoustic modems , Deep space communications [beyond near-Earth Orbit] , Some military ad-hoc networks these are some field where DTN applied and different kind of protocol are used to implement and to forward data correctively to the destination [11,22].

The base protocol that we used in DTN is Bundling Protocol (BP), an application layer protocol that is used to construct a store-and-forward edge network. Bundle Protocol Requires the services of a "convergence layer Adapter" (CLA) to send and receive bundles using an underlying internet protocol. We have well-known Transmission Control Protocol (TCP). This convergence layer is referred to as TCPCL. The locations of the TCPCL and the BP in the Internet model protocol stack is belong between the DTN application and TCP [16].as shown in the figure

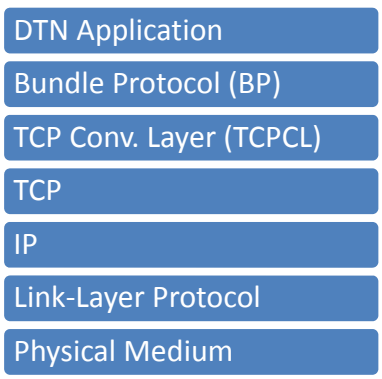


**Figure [1](Location Of bundle Protocol and TCPCL in Internet- Protocol Stack)[13]**

*I. .Bundle Protocol:*

Bundle Protocol sits at the application layer to provide its services, forming a store-and-forward overlay network. Key capabilities of BP include:

- Custody-based retransmission.
- Capability to cope with intermittent connectivity.
- Capability to take advantage of different kind of connectivity.
- Late binding of overlay network endpoint identifiers to constituent internet address.

Bundle protocol take initiative to give custody to the next node that will come in the range of the current node. For that the status report of custody acceptance is generated and flag is set to be 1, a supervision receipt report should be generated, destined for the report-to endpoint ID of the bundle. The bundle protocol agent must generate a "succeeded" supervision signal for the bundle, destined for the bundle's current custodian. Bundle protocol is also giving more services to over the TCP to handle the long delay [13, 21].

*II. TCP Convergence Layer(TCPCL):*

To provide the services TCPCL sits on application layer basic thing behind this protocol to establish a dedicated end-to-end communication path. A TCPCL connection is a TCPCL communication relationship between two node bundle nodes. The lifespan of a TCPCL connection is inevitable to the life time of an underlying TCP connection. Therefore, a connection is initiated when a bundle node initiates a TCP connection to be established for the purpose of bundle communication. The connection will be terminated when TCP connection ends [13].

For this communication we have set of parameter to establish the connection that values affected the operation of the TCPCL for a connection.

In this Survey Paper we are going to extant the different type of protocol that we used in communication we have some criteria that we need to fulfil to get the desired result from the protocol Energy, Security, Buffer Space, Resource Allocation, sparse node and other factor that affect in communication of network they all are also considerable.

The protocol that we have used are categorise on the basis of the nature of the protocol however there is an single idea behind these protocol we have used so on the basis of the nature we have divide these protocol is three category one is Flooding Families another one is Forwarding Families and the last one is Replication Based Routing however we have used these protocol in other application of network where they work more efficiently.

## 2. FLOODING FAMILIES:

In this family, each node contains a number of replicas of each message & conveys them to a set of nodes (sometime called relays). All the relays maintain the replicas and store them in their buffer space until they connect with the succeeding nodes or they encounter the medium to forward the data. The works in the area of DTN routing fall into this family earlier. Using the message replication can increase the possibility of message delivery. The basic protocols in this family do not want any statistics about network. However if some information about network is mentioned to as an additional routing metric, the flooding strategy can be significantly improved. Direct contact, tree-based flooding, epidemic routing, prioritized epidemic routing, probabilistic routing and reconfigurable ubiquitous networked embedded system (RUNES), two-hop relay routing protocols belong to the flooding family [14].

*I. Direct contact:*

*T*his routing protocol allows that data can be conveyed in one hop only. Due to its simple features, it does not consume several resources, and it uses just one message transmission when the source will straight contact with the endpoint. That will transfer the data only in one hop or when the endpoint will come in the range of the source.

*II. Two-hop relay:*

The communication has two hops between source and destination. If there are n nodes nearby the source & straight connect with the source, then there are n replicas of the message should be generated from source, and be conveyed to these nodes.

*III. Tree-based flooding:*

In this routing protocol, the way of drowning is based on tree structure. Both will adopt how to make replicas & confirming the numbers of replicas are important issues in this routing protocol [23].

*IV. Epidemic routing:*

In this protocol all nodes can become the transporter, and it is confirmed that messages can be delivered with a high chance. However, the network resources are consumed heavily. Messages are spread to all neighbours. When there is no room in the message queue, oldest message are dispossessed. Messages are always forwarded according to a FIFO policy and no bound on the number of replicas are considered.

*V. Prioritized Epidemic Routing:*

That protocol has one more quantity that is to enforce a partial ordering on message called Bundles. Therefore one more measure Precedence functions of transmission and removal are used which are based upon four input degree such as the current, cost to destination, the current cost from source, the expiry time & the generation time [23].

*VI. Probabilistic Routing:*

In this Routing when a message attains at a node which doesn't have available connection with other node, it must be stored bundle in the buffer till the node happenstances with further node. That node should have a probability set by user verge on the nodes. It only admits that a node can obtain the message when its delivery probability exceeds the threshold.

| Scheme Name | Hop Count | Resource Usage | Delivery Ration | Routing-vector/table | Multipath support | Effectiveness | Latency |
|---|---|---|---|---|---|---|---|
| Direct Contact | 1 | Low | Min | No | No | Bad | Long |
| Two-hop relay | 2 | Low | Low | No | Yes | Bad | Long |
| Tree-based Flooding | Many | High | Low | No | Yes | Bad | Long |
| Epidemic routing | Many | Max | Max | Yes | Yes | Normal | Long |
| Prioritized epidemic routing | Many | Limited | Normal | Yes | Yes | Good | Normal |
| Probabilistic routing | Many | Limited | Normal | Yes | No | Good | Normal |

**TALE.1. QUALITATIVE COMPARISON OF FLOODING FAMILIES**

3. FORWARDING FAMILIES:

In the forwarding families, the network topology information is used to select the finest path and the message is then accelerated from node to node along with the pathway. These routing protocols need some information about network. The node will attempt to send single message along with the finest path, so they do not use replication. Location based routing, source routing, per-hop routing, per-contact routing, & hierarchical routing protocols belong to the forwarding family [10].

*I. Location based routing*:

In this routing protocol a remoteness function is used to approximation the cost of delivering messages from one to further. The advantage of this protocol is that it requires very rarer information about the network. However, it has two difficulties. The one problem is that even if the distance between 2 nodes is lesser, there is no assurance that they will be able to communicate with each other. The other is that a node's organizes should usually change.

*II. Source routing*:

In brief, source routing means the source node is in control of the whole communicating are regulates the path based on the topology of the network before the message gets hooked on the node. This routing protocol will have respectable performance only when the distance between source and destination is short.

*III. Per-Hop Routing*:

In this routing protocol, the forwarding judgment is made by the intermediary node when a message reaches at the node. The node concludes the next hop for the endpoint & places it in a queue for that contact.

*IV. Per-Contact Routing:*

In this routing table is reorganised each time on the basis of re-computation instead of calculating the next hop for a message. It ensures that each routing choice is made with most current information. However to assurance loop freedom is a big problem.

*V. Hierarchical Routing:*

It is a hop-by-hop routing instead of a source routing. The advantage of this protocol is that it is scalable for Localized traffic patterns and it doesn't need location data. However the contact information is time-variant. For solving this problem, we need a method to collective the time-varying information.

| Scheme Name | Resource Consumption | Information Usage | Routing Vector/Table | Scalability | Loop free | Effective-ness | Delivery Ratio | Latency |
|---|---|---|---|---|---|---|---|---|
| Location Based Routing | Little | Little | No | Bad | Yes | Bad | Min | Normal |
| Source Routing | Normal | Normal | No | Bad | Yes | Bad | Low | Long |
| Per-Hop Routing | Normal | Normal | No | Bad | Yes | Bad | Low | Long |
| Per-contact Routing | Many | Many | Yes | Bad | No | Normal | Normal | Normal |
| Hierarchical Routing | Many | Many | Yes | Good | Yes | Good | Max | Normal |

**TABLE.2. QUALITATIVE COMPARISON OF FORWARDING FAMILIES**

4. REPLICATION-BASED ROUTING:

Replication–based routing has much more courtesy because of its property. They can allow for significantly better message delivery ratio than in forwarding-based protocols. Replication (R) controls and bounds the number of replicas of a message in the network and is used to increase the stoutness of the protocols. Observe that a message that has been selected by the FW policy to be delivered to the current contact is normally deleted from the queue, but the R policy, can enqueue it again in order to have multiple copies into the network.

1. *Single copy*. Messages are never replicated. Once a message has been conveyed to an encounter it is deleted from the line.
2. *Limited*. The total number of copies of a message in the network is bounded.
3. *Controlled*. A message is replicated only if a condition holds.
4. *Unlimited.* There are no constrains on the number of replicas in the network.

*I. Epidemic routing*:

This routing is flooding-based in nature as the nodes constantly replicate and transmit bundle to newly discovered contacts that do not already processes a copy of the bundle. In simple case epidemic routing is flooding; however more refined techniques can be used to limit the number of message handover. To do these two nodes firstly exchange summary routes which contain the list of messages from the other node.

If buffer size is unlimited epidemic routing protocol can achieve optimum delivery prospect and average delay. Since buffer sixe is finite and epidemic protocol generates weighty copies of a message enhance schemes can be used to manage limited buffer and battery energy have been proposed. E.g. Like, **Energy Efficient Epidemic Routing Protocol.**

*II. PRoPHET (Probabilistic Routing Protocol using History of Encounters and Transitivity) routing protocol*:

Epidemic Routing is particularly consumed much more source because it intentionally makes no attempt to eradicate repetitions that would be results not to improve the delivery possibility of messages. This strategy is effective if the opportunistic encounters between nodes are purely random, but in realistic situations, encounters are rarely totally random. Data Mules (mostly associated with a human) move in a society and accordingly tend to have greater probabilities of meeting certain Mules than others. PRoPHET protocol uses non-random movement and contact pattern in real application scenarios to copy messages to other nodes in order to improve the routing concert. PRoPHET protocol uses an algorithm that attempts to exploit the non-randomness of real-world encounters by maintaining a set of probabilities for successful delivery to known destinations in the DTN (*delivery predictabilities*) and replicating messages during opportunistic encounters only if the Mule that does not have the message appears to have a better chance of delivering it [4].

*III. MaxProp (Maximum Priority) :*

MaxProp is forwarding based routing protocol. In MaxProp routing each node primarily set a probability of meeting to all the other nodes in network and also swaps these values to its neighbour nodes. The probability value is used to calculate a destination path cost. Each node forwards messages through the lowermost cost path. MaxProp also uses an ordered queue which is divided into two parts according to an adaptive threshold. MaxProp assigns a higher priority to new messages and forward it first with low hop count and drops a message with the highest cost path when buffer is full. MaxProp has reduced performance when nodes have small buffer sizes because of the adaptive threshold calculation. MaxProp performance is better with large buffer size [19].

*IV. RAPID (Resource Allocation Protocol for Intentional DTN Routing):*

In RAPID models DTN routing as a utility-driven resource allocation problem. In this a packet is routed by replicating it till copy extents the destination. The key question is that how packets should be replicated in the network so as to enhance a specified routing metric. For that RAPID derives a per-packet efficacy function from the routing metric. At a transfer chance, it replicates a packet that nearby results in the highest growth in utility.

For that we have the metric such as diminish average delay of packet minimizing missed deadlines and minimizing maximum delay these are some ideal metrics that is provided by Implication algorithm to give the function correspondence to these metrics. These functions are used to minimize the delay to deliver the packet. So we get the correct routing rules for routing the packets.

*V. Spray and Wait*:

Spray and Wait protocol limits the sightless forwarding message strategy of Epidemic routing by associating a number L to messages that indicates the maximum allowable copies of the message. It consists of two phases spray phase and wait phase. In the spray phase the source node firstly spray L number of message copies to L discrete relay nodes. After getting the message copy all L relay nodes go into the wait stage and wait till the direct transmission to the destination. There are two types of SaW namely Source Spray and Wait and Binary Spray and Wait. In Source Spray and Wait the source node forward all L copies to the first L distinct nodes it encounters. In Binary Spray and Wait the source of a message initially starts with L copies. When it encounters first node with no copies then it hands over $(L|2)$copies to that node and keeps $(L|2)$. Now this process is repeated for both source and relay that has $L > 1$ message copies, and when the node either is left with only one copy, it switches to wait phase and wait till the direct transmission to the destination. The simplicity and thriftiness of direct transmission with the speed of Epidemic routing make SaW well in the terms of performance than Epidemic routing [18].

| Scheme Name | Forwarding Metrics | Number Of Message Copies | Type | Message Replication | Target | Infrastructure assisted |
|---|---|---|---|---|---|---|
| Epidemic Routing | Flooding Based | Multiple | Blind flooding | High | Gargantuan data Propagation | No |
| PRoPHET | Probabilistic metrics | Multiple | Probabilistic | Moderate | Packet Forwarded on the basis of encounter history | Yes |
| MaxProp | Hop count historical data | Limited | Historical data Based | Low | Gives priority to packet in buffer | No |
| RAPID | Utility function | Multiple | Function based | High | Used to minimize the delay | No |
| Spray and Wait | Simple spray and wait | Multiple | Controlled flooding | Moderate | Limited copies are generated | No |
| Bubble Rap Protocol | Label based | Limited | Social Based forwarding | Low | Send the data within Range | Yes |

**TABLE.3.QUALITATIVE COMPARISON OF DTN FAMILIES**

*VI. Bubble Rap Protocol*:

In the LABEL scheme each node is assumed to have a label that apprises other nodes of its affiliation next-hop nodes are selected if they belong to the same affiliation (same label) as the endpoint. This is a beginning of social based forwarding in PSN, but without a concise concept of community and lack of mechanisms to move messages away from the source when the destinations are socially far away. Here we propose the BUBBLE algorithm, with the intention of bringing in a concise concept of community into PSN forwarding to achieve significant improvement of forwarding efficiency. BUBBLE combines the knowledge of community structure with the knowledge of node centrality to make forwarding decisions. There are two intuitions behind this algorithm. Firstly people have varying roles and popularities in society, and these should be true also in the network – the first part of the forwarding strategy is to forward message to nodes which are more popular than the current node.

## 5. CONCLUSION AND CHALLENGES:

In this paper we have studied all the protocol that are sometime related to the delay tolerant network and we conclude that to overcome the problem of routing we can use DTN which can store & forward data from node to node. In this paper we have study all the protocol that some related to DTN and we also provide the qualitative comparison of all the DTN protocol that we have used in previous era and also show that how we overcome from the previous problems. Like in flooding families resources usage is very high in epidemic routing & effectiveness is good in the epidemic routing, prioritized routing. While in the forward families hierarchical routing is best among which provide the maximum delivery ratio? But in the replication based routing we have come with pure DTN protocol in this we have followed all the rule describe by the Bundle protocol to store the data and forward it when medium is available.

The main challenges of DTN are

1. Latency is very High
2. Routing is very Difficult

These two issue are most important issue another is the security that we have to remember in the DTN.

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