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# Analysis of Existing DTN Routing Protocol in a Dense Deployment Scenario with Realistic Mobility Trace

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***Abstract*: *This paper presents the performance analysis of existing DTN routing protocols (*First Contact, Epidemic, Spray and Wait, MaxProp and Prophet*) under dense deployment scenario. To measure the performance of these protocols, delivery probability, overhead ratio, average latency, average hop count and average buffer occupancy metrics are utilized.***

***Keywords*: DTN, MaxProp,** First Contact, Epidemic, Spray and Wait, MaxProp and Prophet, **routing, ONE.**

## I. Introduction

Delay Tolerant Networks (DTNs) are featured with long latency and unstable network topology, where end-to-end delay can be measured in days and routing paths may not exist. These features make traditional routing protocols for mobile ad hoc networks unsuitable for DTNs. This is because most routing protocols for ad hoc networks need to set up a complete end-to-end route with at least one available end-to-end path between the source and destination before packet transferring in the traditional mobile ad hoc network.

To deal with disengagements and long delays in sparse network scenarios, DTN utilizes store-carry-and-forward approach [1, 2]. A network node stores a bundle and hangs tight for a future opportunistic connection. At the point the connection is built up, the bundle is sent to an intermediate node, as indicated by a hop-by-hop forwarding/routing scheme. This procedure is repeated and the bundle will be handed-off hop-by-hop until arriving the destination node. In this context, various diverse routing protocols have been offered for DTNs.

This paper presents the performance analysis of different DTN (Delay Tolerant Networks) routing protocols (first contact, epidemic, prophet, max-prop and spray and wait routing protocols) under dense deployment scenario. In order t***o measure the performance of these protocols, delivery probability, overhead ratio, average latency, average hop count and average buffer occupancy metrics are utilized.***

The rest of the paper is sorted out as follows. Section II presents past work done in the field of mobility models in DTN environment. Section III presents the simulation set up and our comparative analysis and last section concludes the paper.

## II. Literature Review

The work done in [4] shows a relative investigation of numerous DTN routing methodologies for their performance over a cluster-based mobility model. In this research paper, the authors have discovered that MaxProp and Prophet routing protocols are performing better than the other existing routing protocols when a cluster mobility model is in thought. However, it has restricted opportunity of application as disaster relief work may not generally be constrained to cluster-based mobility, where other models may likely be followed. The authors in [5] have proposed few of the DTN routing protocols that are reasonable to work in a post-disaster scenario yet no normalized correlation has been analyzed to recommend better or good protocols. The DTN routing comparison works done in [6, 7] depends on a single mobility model and distinctive routing methods have been assessed over it. The idea of performance comparison over different mobility patterns is novel and presents an extent of genuine usage if there should be an occurrence of any large scale disaster.

Mobility models are separated into broad classifications—specifically Entity-Based model and the other one as the Group-based mobility model [8]. Nodes move exclusively with no impact by other nodes in an entity-based model, whereas in Group-based model the node's movement within groups is influenced by other member nodes. In the Random Waypoint [8] model, which is an Entity-Based mobility model, mobile nodes select destination points haphazardly and travel there with constant speed and some pauses at destinations. Random Walk [8] is again an Entity-Based mobility model which is similar to a Random Waypoint model however having zero pause time. The Shortest Path Map Based mobility model [8] is an Entity-based and map based model which exploits algorithms, for example, the Dijkstra's to compute shortest paths between any two points on the map. Working day mobility model [8] is a Group-based model that models an overall result of numerous sub-models of node mobility during a whole day. It considers day to day common activities of various kinds of people. Cluster Mobility Model [8, 9] is a group-based model that partitions the whole network in a specific number of clusters. Nodes that convey information starting with one cluster then onto the next are Carrier nodes. The other nodes present in each cluster are known as internal nodes. An internal node's movement gets characterized around a Cluster Center. Cluster Mobility Model is most appropriate as a group-based mobility model to emulate a post-disaster scenario.

Uddin et al. [10] have proposed a post-disaster mobility model for a DTN that helps in giving communication in such contexts where it is infeasible and hard to think about an ensured end-to-end connectivity. The mobility model proposed by them uses numerous actors in post-disaster including relief workers of different classifications, transportation network, population movement and relief vehicle movement, and so on.

## III. Performance Analysis Using ONE Simulator

In our simulation scenario a group with 500 pedestrians participating in an event move with 0.5-1.5 m/s in a area 1000m x 1000m. Each node generate approximately 4 messages/hour and send this information to a random destination inside this network. The simulation time is considered 10800 seconds. Other simulation parameters are presented in Table 1.

*Table 1: Simulation Parameter*

| **Parameters** | **Their Values** |
| --- | --- |
| Routing Protocol | First Contact, Epidemic, Spray and Wait, MaxProp, Prophet |
| Simulation Run | 10800 s |
| Node Transmission Speed | 2 – 10 Mbps |
| Node Transmission Range | 10 m |
| Node Buffer Size | 10 MB |
| Wait Time | 0 – 120 s |
| Node Speed | 0.5 – 13.9 m/s |
| Message TTL | 15 minutes |
| No. of Nodes | 500 |
| World Size | 1000 m*1000 m |
| Warm Up | 1000 s |
| Message Size | 100KB |
| Message Creation Interval | 25 – 35 s |
| Mobility Model | Realistic |

### A. *Delivery Probability*

$$Delivery\ Ratio = \frac{Number\ of\ delivered\ messages}{Number\ of\ created\ messages}$$

*Table 2: Analysis in terms of Delivery Probability*

| **Routing Protocols** | **Delivery Probability** |
| --- | --- |
| First Contact | 0.0301 |
| Epidemic | 0.1068 |
| Spray and Wait | 0.0548 |
| MaxProp | 0.1212 |
| Prophet | 0.0603 |

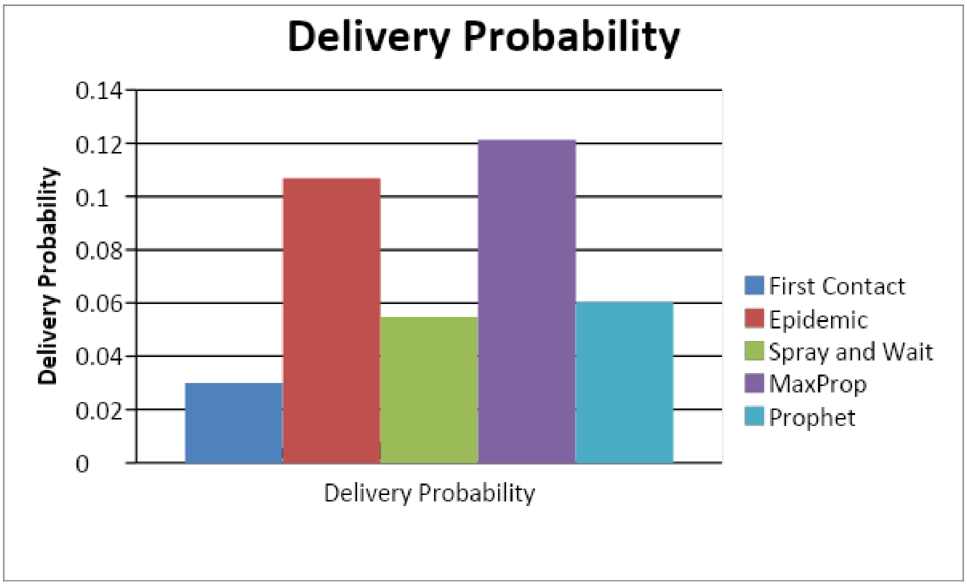


*Figure 1: Analysis in terms of delivery probability*

*B. Overhead Ratio*

$$Overhead\ Ratio = \frac{Number\ of\ relayed\ messages - Number\ of\ delivered\ messages}{Number\ of\ delivered\ messages}$$

*Table 3: Analysis in terms of Overhead Ratio*

| Routing Protocols | Overhead Ratio |
|---|---|
| First Contact | 286.7273 |
| Epidemic | 455.8462 |
| Spray and Wait | 79 |
| MaxProp | 399.25 |
| Prophet | 182.5455 |

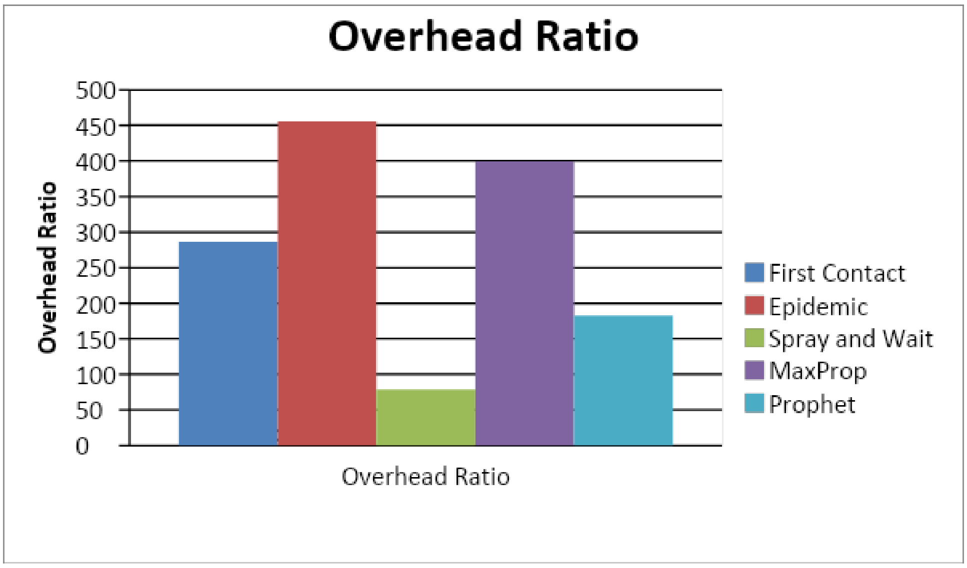


*Figure 2: Analysis in terms of overhead ratio*

*C. Avg. Latency*

$$Average\ Latency = \frac{Sum\ of\ delivered\ message's\ delay}{Number\ of\ delivered\ messages}$$

*Table 4: Analysis in terms of Avg. Latency*

| Routing Protocols | Average Latency |
|---|---|
| First Contact | 323.4273 |
| Epidemic | 558.2333 |
| Spray and Wait | 408.74 |
| MaxProp | 535.945 |
| Prophet | 535.4045 |

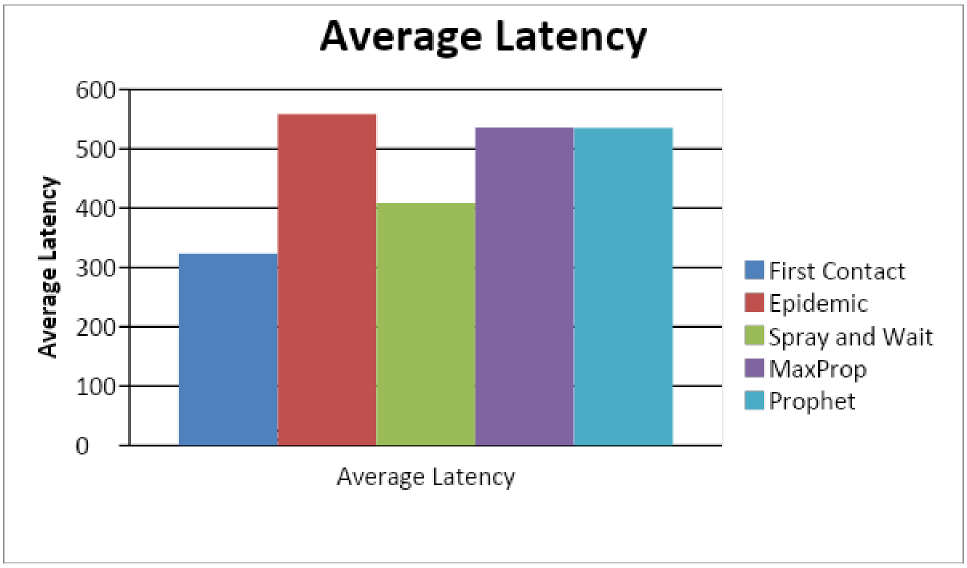


*Figure 3: Analysis in terms of avg. latency*

*D. Avg. Hop Count*

$$Average\ Hop\ Count = Average\ number\ of\ hops\ between\ source\ \&\ destination\ nodes$$

*Table 5: Analysis in terms of Avg. Hop Count*

| Routing Protocols | Average Hop Count |
|---|---|
| First Contact | 7 |
| Epidemic | 3.2821 |
| Spray and Wait | 2.05 |
| MaxProp | 3.55 |
| Prophet | 2.5909 |

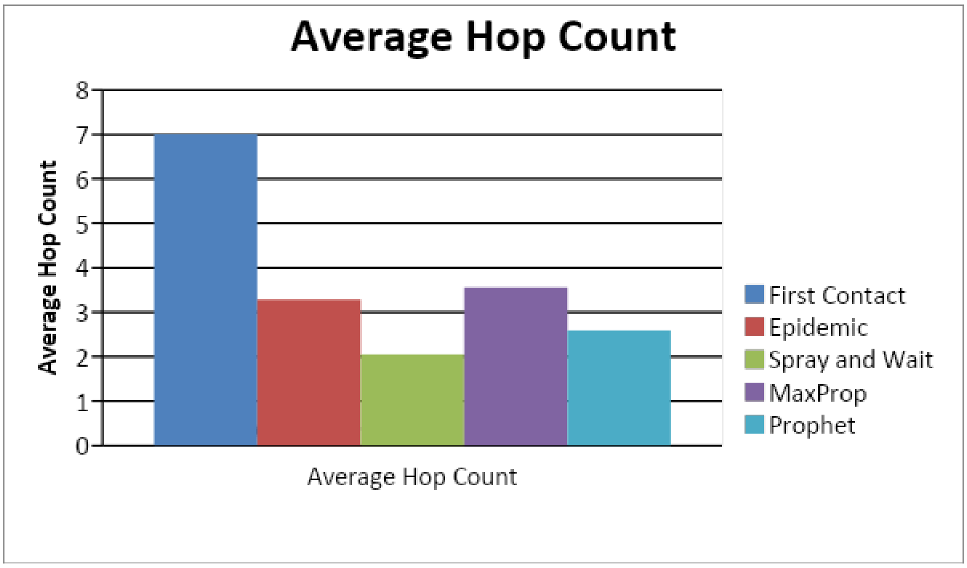


*Figure 4: Analysis in terms of avg. hop count*

*E. Avg. Buffer Time*

$$Average\ Buffer\ Time = Average\ time\ for\ which\ message\ stayed\ in\ buffer\ at\ each\ node$$

*Table 6: Analysis in terms of Avg. Buffer Time*

| Routing Protocols | Average Buffer Time |
|---|---|
| First Contact | 85.2019 |
| Epidemic | 332.2351 |
| Spray and Wait | 688.4967 |
| MaxProp | 322.4143 |
| Prophet | 384.6562 |

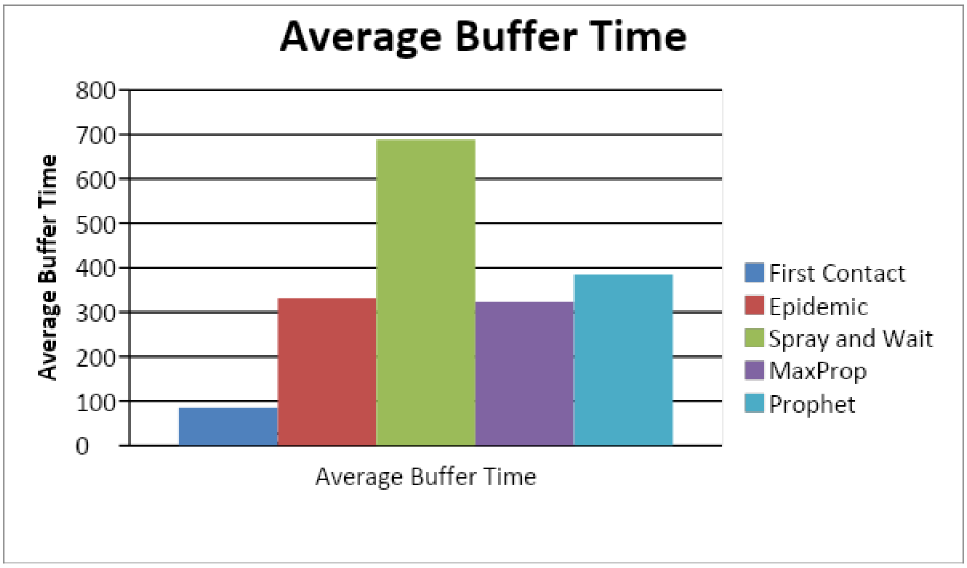


*Figure 5: Analysis in terms of avg. buffer time*

## IV. Conclusion

This work analyses the usage of DTNs in dense deployment scenarios with a high traffic load to transmit the non-critical time data. We took into consideration such scenarios and by simulations compared the performance of five different routing protocols: First Contact, Epidemic, Spray and Wait, MaxProp and Prophet.

It is obvious from the outcomes shown by our paper that no one model is adequate for all the circumstances and diverse situation.

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