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Performance Comparision of Proposed Oracle Based DTN Routing Protocol in a Dense Deployment Scenario

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Abstract
This paper suggests oracle based routing protocol and presents its performance analysis with 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

To provide interoperability among heterogeneous networks, Delay Tolerant Networks (DTNs) architecture was proposed [1, 2]. DTN act as an "overlay" to make the diverse networking architectures inter-operate. Thus, DTN enables to connect the terrestrial Internet with the deep-space network. While traditional Internet use store-and-forward strategy, DTNs provide a paradigm shift by using the store- carry-and-forward strategy. Typical examples of DTNs include, but not limited to interplanetary Internet (IPN) and underwater acoustic sensor networks.

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 to 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 concept of oracle based protocols. Section IV describes 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, Proposed Oracle Based
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*

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

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
Oracle based	0.663

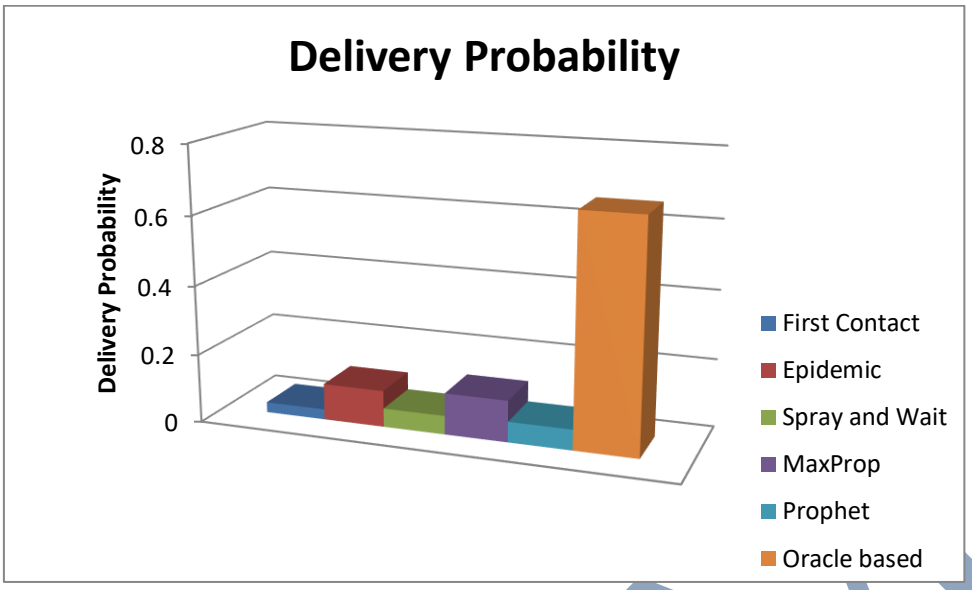

Figure 1: Analysis in terms of delivery probability

B. *Overhead Ratio*

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

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
Oracle based	71.3719

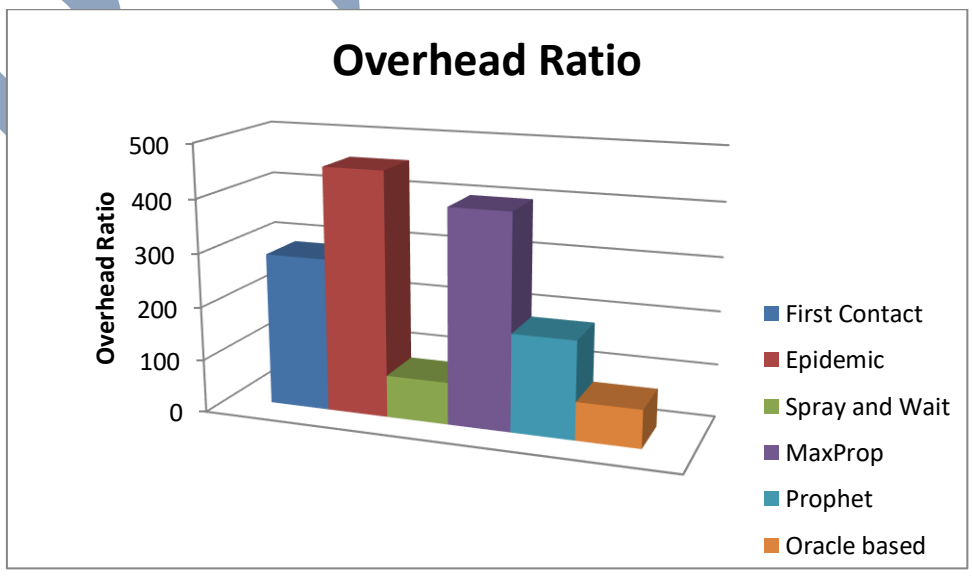

Figure 2: Analysis in terms of overhead ratio

C. Avg. Latency

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

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
Oracle based	2060.653

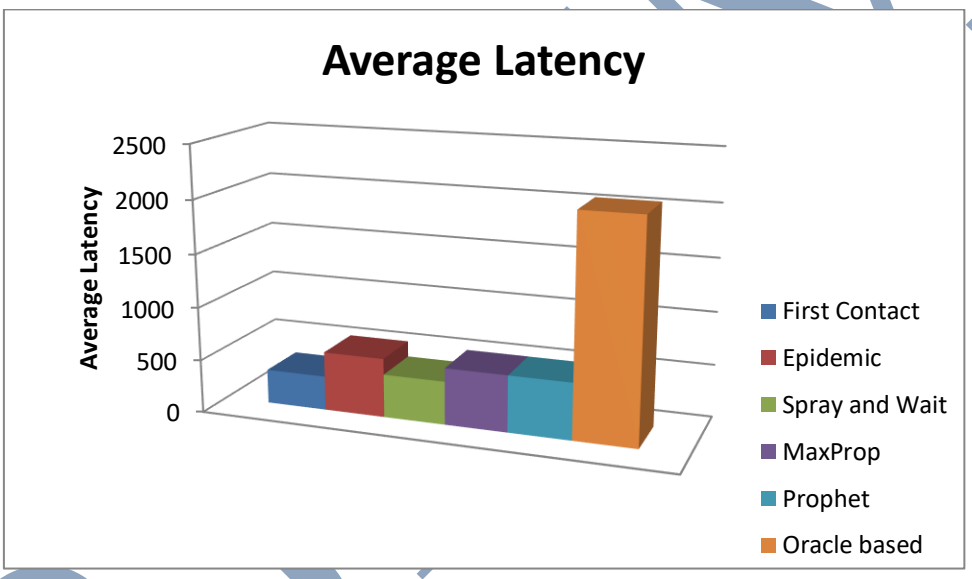

Figure 3: Analysis in terms of avg. latency

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
Oracle based	3.7355

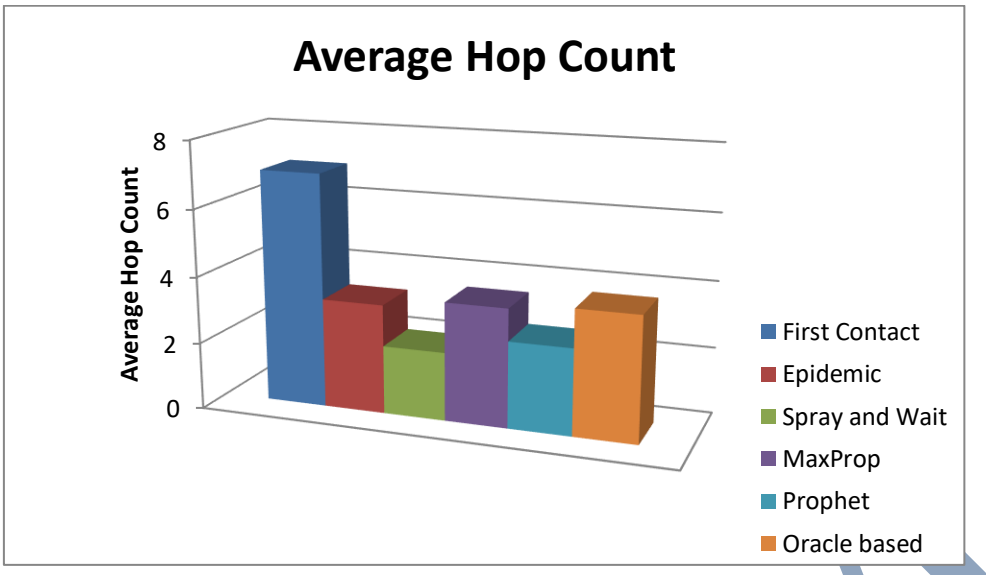

Figure 4: Analysis in terms of avg. hop count

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
Oracle based	1334.445

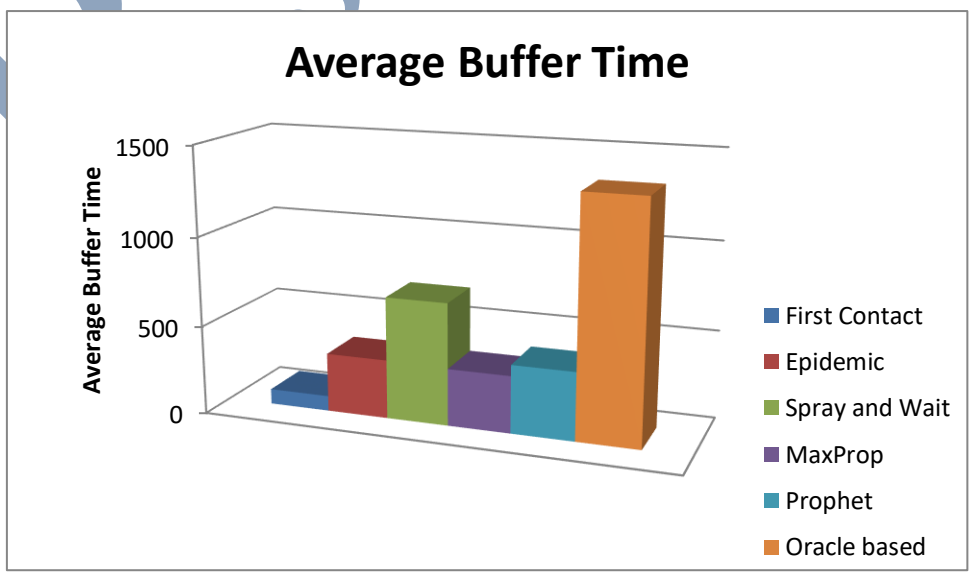

Figure 5: Analysis in terms of avg. buffer time

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.

Moreover, we believe that a hybrid approach, possibly employing some of the epidemic techniques in conjunction with the techniques must be appropriate for such systems. In this work, we have proposed Oracle based routing protocol and the results show that our proposed ortacle based routing protocol performs better as compare to First Contact, Epidemic, Spray and Wait, MaxProp and Prophet routing protocols.

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