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Comparing Different DTN Routing Protocols in a Dense Deployment Scenario with Realistic Mobility Trace

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ABSTRACT

In this paper we propose the usage of Delay Tolerant Networks (DTNs) in dense deployment scenarios where infrastructure access is not available or to reduce the traffic load from congested infrastructure networks for non-time critical applications. The purpose of this paper is to evaluate and compare the performance of different DTN routing protocols in such scenarios where realistic mobility trace is used. The performance is analysed using the metrics of delivery probability, overhead ratio, average latency, average number of hops and average buffer time. The simulation results show that DTN is a good solution to improve the network performance by reducing the traffic load in infrastructure networks and epidemic protocol is the most suitable routing protocol for realistic dense deployment scenarios.

Keywords: Delay Tolerant Networks; Mobile Networks; Routing Protocols; Simulation.

1. INTRODUCTION

Nowadays, the number of mobile devices that use wireless networks [1] for communication is highly increased. In scenarios of dense users the usage of infrastructure networks will increase the traffic load. In high mobility networks and long distances, end to end connectivity is difficult to maintain with current technology and traditional routing protocols fail. In order to solve this issues, we propose the usage of Delay Tolerant Networks (DTNs) [2].

DTNs enable the devices in different regions to interconnect by using message store-carry-forward. The intermediate nodes implement the store-carry-forward message switching mechanism by using the bundle layer, on top of heterogeneous region-specific lower layers. In a DTN, each node can act as a host, a router or a gateway and must have persistent storage and support custody transfers. When the node acts as a router, the bundle layer can store, carry and forward the bundles between the nodes in the same region. A gateway can forward bundles between two or more regions.

In this research work, we compare the performance of five different routing protocols: Direct Delivery, First Contact, Epidemic, Spray and Wait and Prophet. A DTN is created to deliver non time critical data such as photos or emails. Performance evaluation results, based on simulation, show that DTN is a good solution to improve the performance of congested infrastructure networks by reducing the traffic load. In realistic scenarios with high density epidemic routing protocol performs better than other considered protocols.

The remainder of this paper is as follows. Section 2 introduces routing in Delay Tolerant Networks. The simulation scenarios and parameters are presented in Section 3.

Section 4 shows the simulation results. Finally, the conclusions and future work are presented in Section 5.

2. ROUTING IN DELAY TOLERANT NETWORKS

DTN routing protocols are classified in single-copy and multiple-copy [3-8]. As the name suggests in single-copy routing protocols, only one copy of each message exists in the network. In multiple-copy routing protocols there are two subgroups: n-copy routing protocols and unlimited copy routing protocols. N-copy protocols limits the number of message copies created to a configurable maximum and distributes these copies to contacts until the number of copies is exhausted. Unlimited copy routing protocols that are variants of flooding.

In this work, we will use five widely applicable DTN routing protocols: Direct Delivery, First Contact, Epidemic, Spray and Wait and Prophet. In the following is a detailed explanation for each protocol.

Direct-Delivery is a single copy protocol. The messages are only delivered to their final destination when the sender node encounter directly the destination node.

In First contact, the nodes forward bundles to the first node they encounter. This results in a random search for the destination node. If any node comes first into the radio range of the source node will be given the message. It doesn't determine the next best hop moving to the destination. The message is forwarded randomly when two or more nodes come in contact with the source node at the same time. Local copy of the message is eliminated after successful transfer from one node to another node. Thus, a single copy of the message flows in the networks.

Epidemic protocol uses flooding mechanism. It spread the messages in the network without priority and without limit. When two nodes encounter each other they exchange a list of message IDs and compare those IDs to decide which message is not already in storage in the other node.

Spray and Wait protocol uses two phases: the spray phase and the wait phase. When a new message is created in the system, a number L is attached to that message indicating the maximum allowable copies of the message in the network. During the spray phase, the source of the message is responsible for “spraying”, or delivery, one copy to L distinct “relays”. When a relay receives the copy, it enters the wait phase, where the relay simply holds that particular message until the destination is encountered directly.

Prophet is a variant of the epidemic routing protocol. It uses the delivery predictability that attempts to estimate, based on node encounter history, which node has the higher probability of successful delivery of a message to the final destination. When two nodes are in communication range, a new message copy is transferred only if the other node has a better probability of delivering it to the destination.

3. SIMULATION SCENARIOS AND PARAMETERS

We propose the usage of DTNs as an alternative for communication in order to solve problems of congested infrastructure networks in case of events with a big number of users. 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 3 hours. Other simulation parameters are presented in Table 1.

For the simulations, we use the Opportunistic Network Environment (ONE) [9] simulator. ONE is capable of generating node movement using different movement models and can import mobility data from real-world traces. It offers various DTN routing algorithms for routing messages between nodes. Its graphical user interface visualize both mobility and message passing in real time and can also produce a variety of reports from node movement to message passing and general statistics.

Table 1. Simulation parameters.

Parameter	Value
Number of nodes	500
Simulation area	1000m x 1000m
Interface	Bluetooth
Movement model	Realistic
Simulation Time	3h
Message TTL	15 min
Events Interval	25-35 s
Message size	100kB
Buffer size	10M

4. SIMULATION RESULTS

In this section, are presented the simulation results. The simulation results of delivery probability for all considered routing protocols are shown in Figure. 1. The delivery probability is the ratio of number of delivered messages to that of created messages. From the results, higher delivery probability is achieved from epidemic protocol. Around 95% of data sent are received at the destination. Epidemic uses multiple copies of messages and for this reason more nodes will have the messages and the probability to encounter the destination node is high. Direct delivery have the lowest delivery probability because there is only one copy in the network and the source node should encounter directly the destination node to send the information. Direct delivery is not suited for this scenario.

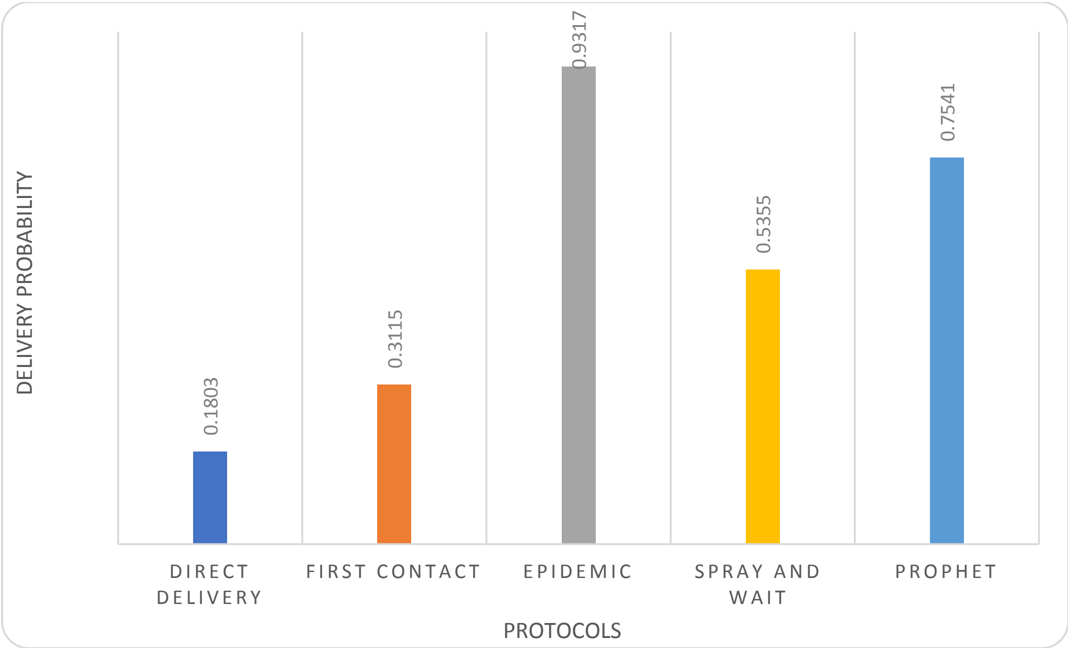

Figure 1. Results for delivery probability.

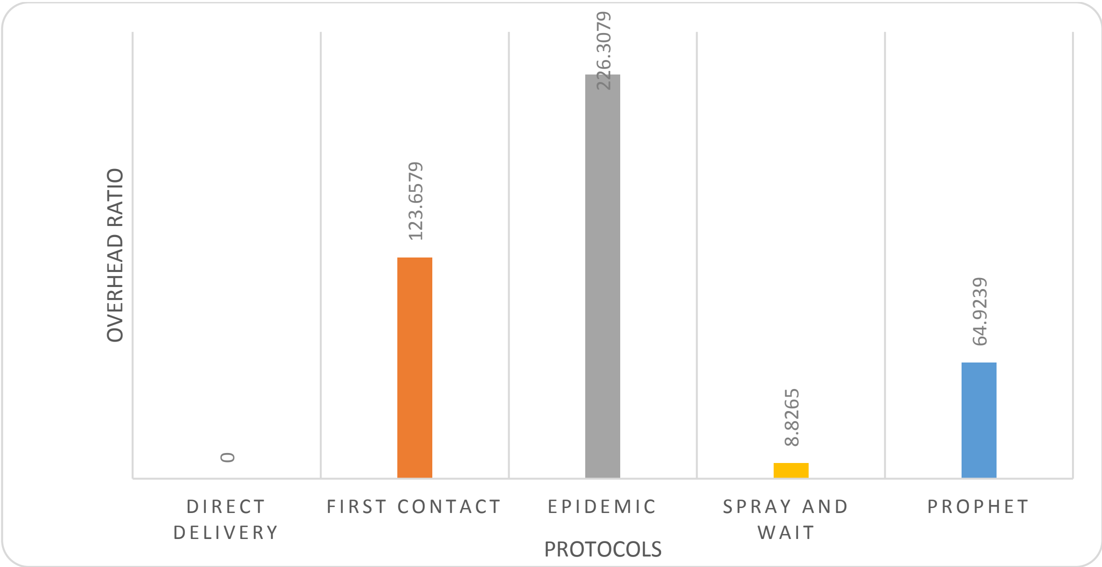

Figure 2. Results for overhead ratio.

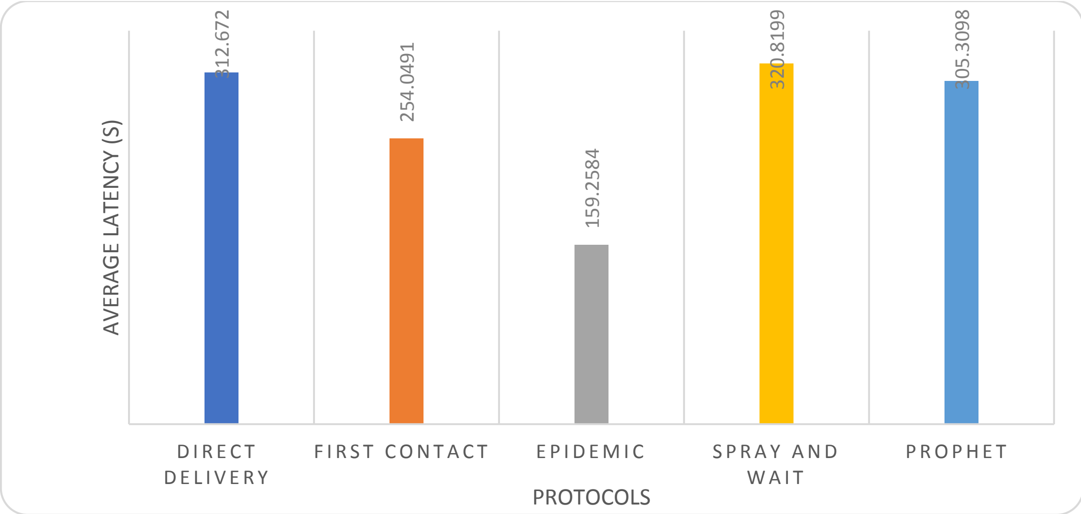

Figure 3. Results for average latency.

The simulation results of overhead ratio are shown in Figure. 2. Overhead ratio is calculated as the difference relayed and delivered messages upon the number of delivered messages. Since epidemic uses the biggest number of message copies this results in high overhead ratio. The overhead ratio for direct delivery is zero. Spray and wait have a low overhead ratio because the number of copies in the network is limited.

In Figure. 3 are presented the results for average latency. The average latency is calculated as the average time elapsed from the creation of the messages at source to their successful delivery to the destination. Best results for the average latency are achieved from epidemic protocol.

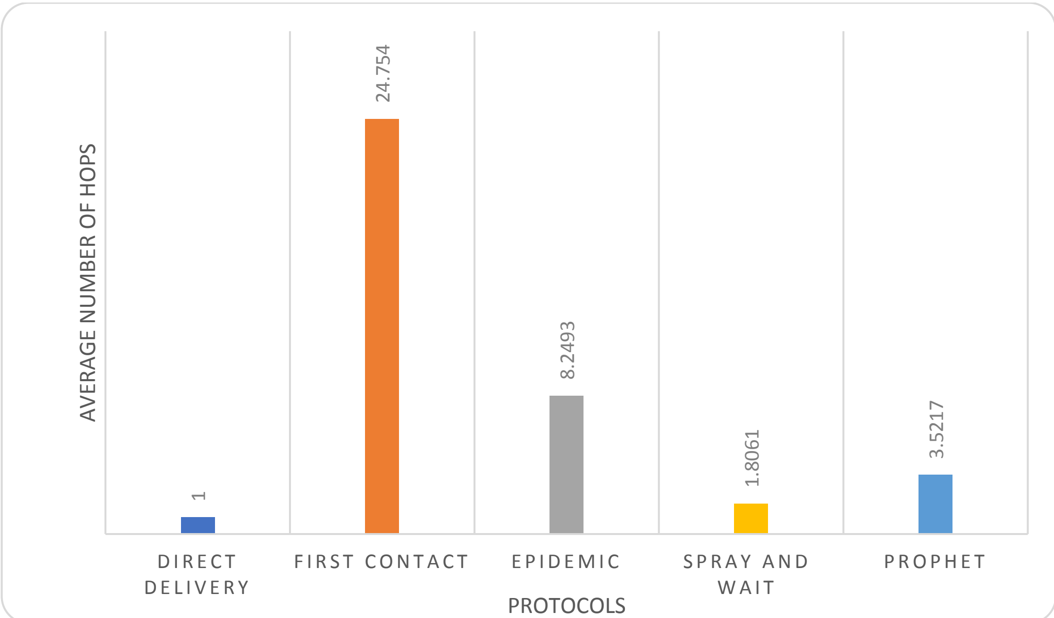

Figure 4. Results for average number of hops.

Figure. 4 shows the simulation results for average number of hops. Average number of hops is calculated as the average number of hops counts between the source and the destination node of bundles. Direct delivery uses less hops. First contact uses a big number of hops. Epidemic protocol uses an average of 7 hops to reach the destination.

From the results, epidemic protocol is the most suited for this non critical time application in a dense scenario since it achieves the highest delivery probability and the lowest average latency.

3. CONCLUSION

In this research work, we proposed 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: Direct Delivery, First Contact, Epidemic, Spray and Wait and Prophet. The simulation results, show that in realistic scenarios with high density epidemic routing protocol performs better than other considered protocols and DTN is a good solution to improve the performance of congested infrastructure networks by reducing the traffic load.

In the future, we would like to implement an energy-aware routing protocol for DTNs with high delivery probability and low overhead ratio and evaluate its effectiveness by comparing with other protocols.

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REFERENCES

[1] Tamre M, Hudjakov R, Shvarts D, Polder A, Hiiemaa M, Juurma M, Implementation of Integrated Wireless Network and MATLAB System to Control Autonomous Mobile Robot, International Journal of Innovative Technology and Interdisciplinary Sciences, 2018, 1 (1), pp. 18-25.

[2] Fall K, A delay-tolerant network architecture for challenged Internets, in Proceedings of the International Conference on Applications, Technologies, Architectures, and Protocols for Computer Communications, ser. SIGCOMM-03, 2003, pp. 27-34.

[3] Massri K, Vernata A, Vitaletti A, Routing Protocols for Delay Tolerant Networks: a Quantitative Evaluation, In Proceedings of ACM workshop PM2HW2N-12, 2012, pp. 107-114.

[4] Jain S, Fall K, and Patra R, Routing in a Delay Tolerant Network, in Proceedings of ACM SIGCOMM 2004 Conference on Applications, Technologies, Architectures, and Protocols for Computer Communication, Portland, Oregon, USA, August 30-September 3, 2004, pp. 145-158.

[5] Spaho E, Dhoska K, Bylykbashi K, Barolli L, Kolici V, Takizawa M, Performance Evaluation of Routing Protocols in DTNs Considering Different Mobility Models, Proceedings of the 15th International Symposium on Frontiers of Information Systems and Network Applications (FINA-2019), 2019, pp. 205-214.

[6] Bylykbashi K, Spaho E, Barolli L, Xhafa F, Routing in a many-to-one communication scenario in a realistic VDTN, Journal of High Speed Networks, 24(2), 2018, pp. 107-118.

[7] Bylykbashi K, Spaho E, Barolli L, Xhafa F, Impact of node density and TTL in

vehicular delay tolerant networks: performance comparison of different routing protocols, International Journal of Grid and Utility Computing, 7(3), 2017, pp. 136-144.

[8] Spaho E, Dhoska K, Bylykbashi K, Barolli L, Kolici V, Takizawa M, Performance Evaluation of Energy Consumption for Different DTN Routing Protocols, Proceedings of the 21st International Conference on Network-Based Information Systems (NBiS-2018), pp. 122-131.

[9] Keranen A, Ott J, and Karkkainen T, The ONE Simulator for DTN Protocol Evaluation, in Proceedings of the 2-nd International Conference on Simulation Tools and Techniques (SIMUTools-2009), 2009, pp. 1-8.