Applied GIS

ISSN: 1832-5505
Vol-6 Issue-01 Jan 2018

Refining the Opportunistic Network (OppNet) Protocol for Efficient and Effective Communication

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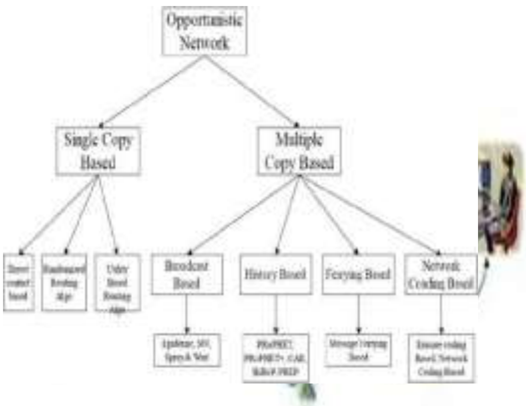
***Abstract*— It is clear that MANETs have evolved into opportunistic networks. Nodes in opportunistic networks only talk to each other when they have a chance to talk, and the path linking them to mobile nodes is always open. Moreover, it is not expected for mobile nodes to have or learn the topology. At the same time as messages are being routed from their origin to their destination, network routes are being constructed in real time, and any available node may be utilized as next hop if it is likely to get the message closer to its ultimate destination. These specifications make OppNet a demanding but potentially fruitful area of study.**

***Keywords*— Opportunistic networks, routing, One-to-many and many-to-one copy routing**

INTRODUCTION

Opportunistic networking does not presume the preexistence of a fully connected route between



communicating nodes. Nodes at both ends of a transmission may be simultaneously joined to the same network. However, using opportunistic networking protocols, these nodes may still communicate with one another. It is possible that intermediary nodes may need to buffer messages for a considerable amount of time, and their movement will need to be discouraged so that they get at their destination as close as possible by exchanging messages with neighboring nodes whenever possible [1].

Fig. Opportunistic Networking [1].

In Fig.1, for instance, the guy at the computer sends a message for a buddy through a Wi-Fi connection to a bus passing through the neighborhood in the "hope" that the bus would deliver the data to its final destination. A female is getting off at one of the bus stops, and while the bus passes through the traffic, the driver utilizes the Bluetooth radio to transmit the message to her phone. The girl gets to school by way of a nearby park on her way to college. Her phone texts the message to a passing bike. The message reaches the intended recipient after following the same path for a few more hops. Although the two ladies never establish a direct network connection, the message is finally sent to its intended recipient by taking advantage of random connections between several devices.[1]

ROUTING TECHNIQUES IN OPPORTUNISTIC NETWORKS

Opportunistic networks have limited access to network resources. The performance of such networks is dependent on a number of factors, including the bandwidth available to each node and the battery life of each node. Because there is no predetermined topology and nodes often get disconnected, routing in opportunistic networks is challenging. Designing an efficient routing method for an inopportunistic network is difficult since its topology is unknown. When more information about the predicted topology of the network is suppressed, routing performance improves [2]. Unfortunately, such information is scarce, so it's necessary to strike a balance between how well something performs and how much you need to know about it.

Fig. shows the different routing algorithms in opportunistic networks. At the bottom of Fig. we list the examples of each class that we will mention in this paper.

Fig. Routing in opportunistic network

SINGLE-COPY ROUTING SCHEMES

A. Direct contact based algorithm

Direct contact based algorithm was examine the problem of efficient routing in occasionally connected mobile networks using single-copy methods. Spyropoulos [4] proposed a simple single-copy routing called direct broadcast routing. In this approach, after the source node generates a message, the message is hold by the source node until it reaches the destination node. The main advantage of this scheme is that it acquires minimum data transfers for message deliveries. On the other hand, although having minimal overhead, this scheme may acquire very long delays for message delivery since the delivery delay for this scheme is limitless [5].

MULTIPLE-COPY ROUTING SCHEMES

A. Broadcast based algorithms

Routing techniques based on message broadcasting perform transfer of a message to a destination by simply broadcasting it all over the network. This policy is used because, there is no knowledge of a possible path towards the destination nor of an suitable next-hop node, should a message be sent everywhere. It will eventually reach the destination by passing node by node. Broadcast-based techniques obviously work well in highly mobile networks where contact opportunities, which are needed for data diffusion, are very common. They incline to limit the messages delay, but they are also very resource hungry. Due to the substantial number of transmissions involved,

1. Epidemic routing

Epidemic Routing [6] depend on on the theory of epidemic algorithms by doing pair-wise information of messages between nodes as they get contact with each other to finally deliver messages to the destination. Nodes buffer messages when there is no accessible path to the destination. An index of these messages called a summary vector is kept by the nodes, and when two nodes meet they interchange them. So doing, each node can regulate if the other node has some message that it did not see before and requests it. This means that, as long as there is some available buffer spaces, messages will spread epidemically as a disease, as nodes meet and ―infect‖ each other. Moreover the obvious fields of source and destination addresses, messages also contain a hop count field. This field is similar to the TTL field in IP packets and regulates the maximum number of hops a message can be sent, and can be used to bound the resource utilization of the protocol.

2. MV routing

The routing protocol MV [7] maintains a movement model of the network participants and uses this information to perform routing of messages on the network. It estimates the probability of a particular message being delivered by a given peer, and thus is capable of making informed routing decisions.

The MV routing protocol is a further step beyond epidemic routing. Messages are exchanged during pair-wise contacts as in epidemic routing for the neighbor node that has the highest amount of time encountering D, meaning that has the highest delivery predictability to D. This property is further transitive.

3. Context aware routing

In the Context-Aware Routing (CAR) protocol [11] each node in the network is in custody of producing its own delivery probabilities towards each known destination host. Delivery possibilities are swapped periodically so that, eventually, each node can calculate the best carrier for each destination node. The best carriers are computed based on the nodes' context. The context attributes needed to elect the best carrier are, for example, the residual battery level, the rate of change of connectivity, the probability of being within reach of the destination, the degree of mobility. When the best carrier receives a message for sending, it stores it in a local buffer and eventually forwards it to the destination node when met, or otherwise to alternative node with a higher delivery probability. CAR provides a framework for calculating next hops in opportunistic networks based on the multi-attribute utility theory applied to generic context attributes.

B. Network coding based algorithms

The concept of network coding allows interior nodes of a network to not only forward but also to process information they receive.

1. Erasure based coding

Erasure codes [12] operate by converting a message into a larger set of code blocks such that any sufficiently large subset of the generated code blocks can be used to reconstruct the original message. The basic idea is to erasure code a message and distributes the generated code-blocks over a large number of relays. Instead of sending a full copy of the message over a relay, only a fraction of code-blocks are sent over each relay. This controls the routing overhead in terms of bytes transmitted, and the average delay can be reduced to a small constant. Erasure coding can also help to combat packet loss due to bad channel quality or packet drops due to congestion.

2. Network coding based

Network-coding-based routing [3] is similar to probabilistic routing but is based on network coding. Network coding is a relatively recent field in information theory. In contrast to simply forwarding the information contained in the packets, nodes may send out packets with linear combinations of previously received information. Network-coding-based routing limits message flooding. Just to give a classical example, let A, B, and C, be the only three nodes of a small network. Let node A generates the information ―a‖ and node C generates the information ―c‖. Then suppose the information produced needs to be known at all the nodes. Hence, node A and node C send their information to node B. Then node B, rather than sending two different packets for ―a‖ and ―c‖, respectively, it broadcasts a single packet containing ―a‖ xor ―c‖. Once received ―a‖ xor ―c‖, both nodes A and C can finally infer the missing information (i.e., node A can infer ―c‖ and node C can infer ―a‖). Network coding-based routing outperforms.

2. **PROPHET**

In the Probabilistic Routing Protocol using History of Encounters and Transitivity [10], the selection of the best neighbour node is based on how frequently a node encounters another. Prophet uses a probabilistic metric called delivery predictability that indicates how likely it is that A will meet B, and thus that will be able to deliver a message to B. When two nodes meet, they exchange their summary vectors, which contain their delivery predictability information. If two nodes do not meet for a while, the delivery predictability reduces. When the sender wants to send a message to the destination D, it will look for the neighbor node that has the highest amount of time encountering D, meaning that has the highest delivery predictability to D. This property is further transitive.

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―c‖ and node C can infer ―a‖). Network coding-based routing outperforms flooding, as it is able to deliver the same information with a fewer number of messages injected into the network.

D. Ferrying based algorithms

The Message Ferrying (MF) [14] scheme is a proactive approach for data delivery in sparse networks. It introduces non- randomness to node mobility and exploits such non-randomness to provide physical connectivity among nodes. In an MF scheme, the network devices are classified as message ferries or regular nodes based on their roles in communication. Ferries are devices which take responsibility of carrying messages among other nodes, while regular nodes are devices without such responsibility. There are many different ways to introduce non- randomness in node movement, as in the node- initiated MF scheme ferries move around the deployed area according to known routes, collect messages from regular nodes and deliver messages to their destinations or other ferries. With knowledge about ferry routes, nodes can adapt their trajectories to meet the ferries and transmit or receive messages. By using ferries as relays, nodes can communicate with distant nodes that are out of range.

I. AN IMPROVED PROTOCOL FOR MESSAGE PASSING IN OPPORTUNISTIC NETWORK

An opportunistic network is a type of challenged network in which contacts (i.e. communication opportunities) are intermittent. Moreover, an end-to-end path between the source and the destination may never have existed, disconnection and reconnection are common occurrences, and link performance is highly variable or extreme. Therefore, traditional Internet and Mobile Ad-hoc Network (MANET) routing techniques cannot be applied directly to opportunistic networks.

Routing in opportunistic network is one of the most compelling challenges. The design of efficient routing strategies for opportunistic networks is generally a complicated task due to the absence of knowledge about the topological evolution of the network. Routing performance improves when more knowledge about the expected topology of the network can be exploited

Routing in Opportunistic Network and provide details of work carried out while routing the message in opportunistic network environment. In particular, we will suggest our approach to give improved delivery of messages for routing in opportunistic networks.

VI EXPERIMENTS AND RESULTS

I've built a wireless network simulator to analyze and evaluate the ProEp protocol. A representation of wireless nodes has been included in the simulator. The simulator is also limited in the total number of nodes it can support. Within the defined region, nodes are moving at a variable rate of randomness. To help in the evaluation of the protocol, I have created a basic simulator. The simulator focuses on how the routing protocols work but ignores simulating the fundamental layers in any depth. It is crucial to employ realistic models when doing an estimate of a protocol or system. It is crucial that the mobility models I employ are accurate, since our protocol is based on generating predictions based on the motions of nodes. The random way-point mobility model is one kind of model that has been used often in evaluating ad hoc routing methods. In this scenario, nodes choose their next location and velocity at random. Nodes arrive to their final destination, rest for a bit, and then decide where to go next.

Here, I refine the provided procedure and compare its performance using the indicators listed below. To begin, I'm curious in the time it takes for a message to be sent, or the message delivery delay. Changing the hope count and queue size is something to think about even if applications employing this form of communication should be quite latency tolerant already. This is vital so that scarce resources like bandwidth and energy are not squandered, since it reveals how the various parameters effect the system's resource use.

Multiple simulation runs were conducted for each scenario, with parameters such as the hop count value in the messages and the queue size at the nodes changing. The following settings are held constant throughout our simulation:

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Parameter	Values
Pinit	0.75
γ	0.25
B	0.98

Fig Parameter Setting

The setup of experiment includes 24 nodes on approximately 100m X 100m. I am taking nodes with varying hop count & queue size. Nodes ranges from 16 to 24 with the hop count value 3 & 5 and queue size with 5 and 10 number of message storing capacities.

Results

The performance could be measured using the following parameters:

1. Number of hop count given for the message.
2. Queue or buffer size of the node.
3. Travelling time (delay) of the message from source to the destination.
4. Number of nodes available on the field.
5. Speed of node

1] Result analysis using Travel time (delays)

Initially I am taking different nodes separately and observe the effect with change in hop count and queue size value with all four combinations. In each case I plotted a graph with reference

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As seen in Fig, decrease in the number of nodes the direct effect on the delays. When hop count is 3, the average travel time is lesser than hop count value 5. It is because if decrease in the hop count value, there will be less number of intermittent nodes. If message will reach to its hop count value message would be dropped. So when hop count value was less and tried to send message with such minimum value, if destination was not found within that hop count value, ultimately message was

dropped. So it is better to have minimum value for hop count which ultimately goes through lesser number of intermittent nodes and requires less time to travel. But chosen low value for hop count this will leads to message drops when hop count value will reach. And increase in the value for hop count affects greater delays.

After that changing the values of queue size and then observe the changes which shown in Fig. Now in this case increase in the size of queue, the delays would be increases. As we know, queue means the buffer which holds the message generated by self and received while moving around the network for routing purpose. So when increase in the buffer capacity so fewer messages would drop. But this will affect the message exchange capabilities, when more messages are in queue it can_t

ISSN: 1832-5505
Vol-6 Issue-01 Jan 2018

dropmore messages for new ones.

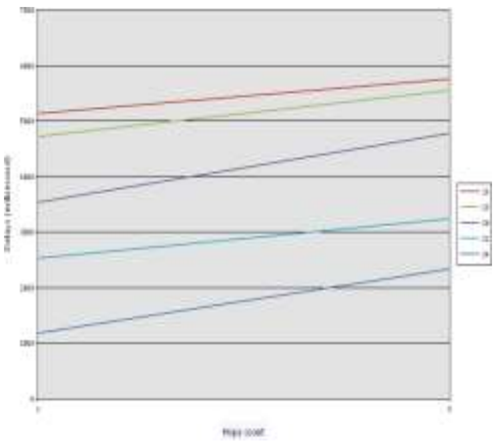


Fig Graph of Queue size vs. delay with differentnodes

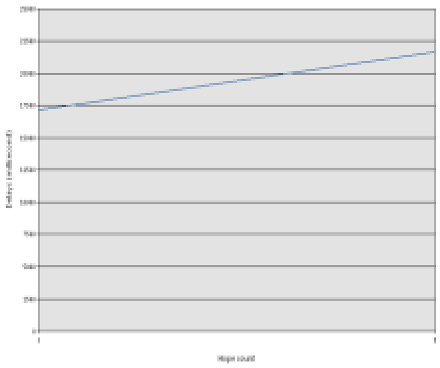
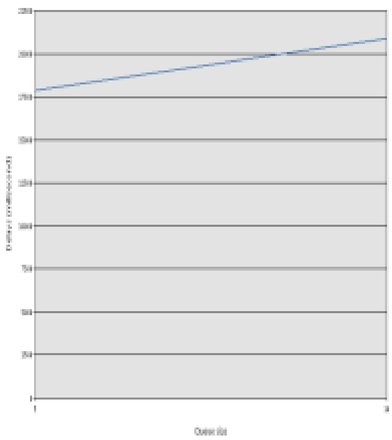


Fig Graph of Hope count vs. delay



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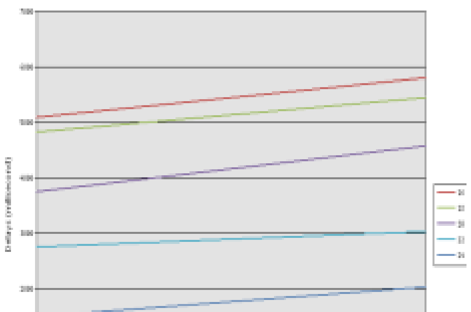

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Result analysis using Speed of node

Considering the speed of nodes is important aspect through that many things are affected. As changes in the speed of nodes the hop count value and queue size affected. I assign some random values for speed of the nodes. Finally calculate the average speed of nodes for the instance in which simulation is running.

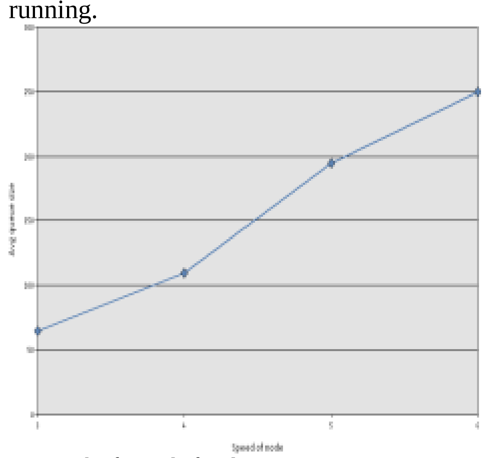

Fig Graph of Speed of node vs. Average queuesize

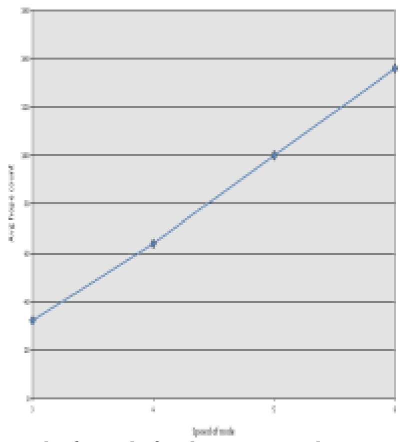

Fig Graph of Speed of node vs. Average hopecount

Simulation Parameter

Parameter	**Value**
Total Simulation Time	5000 seconds
World Size	450 X 340 m
Movement Model	RandomWaypoint

Routing Protocol	PRoEp, Prophet, Epidemic
No of Nodes	5,10,20,30,40,50,100
Interface Transmit Speed	2 Mbps
Interface Transmit Range	100 m
msgTTL	300 min
Node Movement Speed	Min=0.5m/s Max=1.5m/s
Message creation rate	One message per 25-35 sec
Message Size	500 to 1MB

Table Simulation Parameter

I. Conclusion

These techniques will allow message delivery in the case where a connected path from source to destination is never available in mobile ad hoc networks. While existing ad hoc routing protocols are robust to rapidly changing network topology, they are unable to deliver packets in the presence of a network partition between source and destination.

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