Simulation of Carry Protocol (c-protocol) in MANET

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A network is a number of computers or devices that are connected to each other through physical or wireless links. The main advantage of having networks is to be able to share resources and services among the connected devices. In order to have sufficient and beneficial communications, the data transfer between the connected devices is governed by a protocol (a communication rule). There is a huge number of protocols that are used in networking. Each protocol has its own services and operates over specific types of network. Wired networks have specific protocols or specific versions of a protocol that would not necessarily work efficiently over wireless network. For that reason, the protocols have to be modified or changed in order to serve different types of networks.

With the presence of the Internet, having a home or an office network connected to the world is relatively a simple and easy task, especially these days with the huge improvement in the Internet services. However, this is not the case in every network. There are some networks that have to operate in extreme environments. These types of networks have to be treated in different ways to achieve the most efficient type of communication. Examples of such networks are Terrestrial Mobile Networks, Exotic Media Networks, Military Ad-hoc Networks and Sensor/Actuators Networks [1, 2].

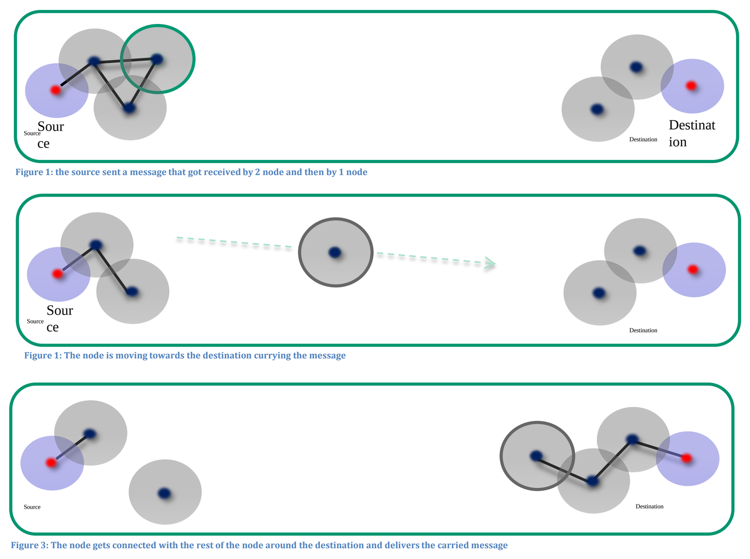
Objectives

In order to exchange messages or packets between any two nodes, the existing MANET networks require an end-to-end direct path. The problem is that, with the breaking of direct path between the source and the destination, a message is dropped and lost each time the connection is lost. In order to overcome this problem, a message may be carried by the intermediate nodes and may have to stay there for some time until the nodes get connected to each other. Then, the message is retransmitted again. Our objective is to test such a scenario by simulating different versions of data carrying protocols.

Proposed solutions

Different versions of carry protocols are proposed . These versions are; (1) First hop in the list routing (FLR), (2) closest hop routing (CHP) and (3) farthest hop routing (FHR). By introducing a GPS location (Global Positioning System), so that the distance to each node in the topology is known, (4) the closest to the destination routing (CGPS) and (5) forwarding to the hop that has the best next location to the destination (NGPS) are proposed. One last version of the c-protocol is simple flooding. In order to understand the underlying implementation of each version, a brief discussion is mandatory.

In First in the list routing, the first node spotted, by the node currently carrying a packet (the carrying hop), is the one the packet is forwarded to. In closest hop routing, the distance between each connect node is calculated and the packet is forwarded to the one that is closest to the carrying node (in other words, the one having the strongest transmission signal). In farthest hop routing, the packet is forwarded to the farthest node from the carrying node (in other words, the one having the weakest transmission signal).



The movement of the nodes is considered random in this work. The way the nodes move is by generating a random X and Y coordinate (treated as the next location and bounded by the network area) and then move at a constant speed towards this next location. After the next location is reached, it is set to be the current location and a new next location is generated. The movement pattern used in the simulation is the same pattern used by the SetDest utility supplied with Network Simulator 2 (NS2) [6]. In GPS enabled routing, the current position of the destination is known to all the nodes in the network. In closest to destination routing, the distance between every connected node and the destination is calculated and sent to the carrying hop. The packet then is forwarded to the closest node to the destination. Since there is movement involved in the network, it cannot be guaranteed that the closest node to the destination is not moving away from the destination. To overcome this issue, forwarding to the closest *next location* to the destination is proposed. Rather than sending the packets to the closest current location of the node to the destination, they are forwarded to the node that has the closest next location to the destination.

Simulation environment

When designing any protocol, a set of requirements has to be specified such as: guaranteed delivery, in-order delivery, packet duplication, etc. In this particular type of network topology, the movement pattern and density of the intermediate nodes plays a big role in designing the c-protocol. For testing, the implementation of the actual mobile nodes could be expensive and time consuming. We considered using an existing simulator (like NS2) but require a significant effort to add a new protocol [6]. Instead, a customized JAVA simulator was used to simulate the network and to develop the c-protocol. The JAVA simulator provides a controlled environment for testing the c-protocol and provides a full control over the parameters and the algorithms used by the c-protocol.

Assumption

Table 1 contains a set of parameters used in the simulation along with their values.

Two simulation scenarios were used in testing. One with N=7 mobile nodes and the other with 50. The graph shows that, in this experiment, the source and the destination are never connected by a closed path. Lack of end-to-end path in conventional MANETs prevents the data from being delivered. This issue has been addressed by introducing carrying feature implement in c-protocols.

Parameter	Value
Src and Dest nodes	Stationary.
Intermediate nodes	Mobile. V= 1m/sec
Network area	400m x 400m
Number of nodes	N = 7. (Low density)
Transmission range	50m
Packet generation interval	800 millisecond
Forward cycle	200 millisecond.
Location update	10 millisecond
End-to-end connection	Updated every 1 millisec
Throughput	Calculated every 5 sec
Buffer Size	50 packets
Packet size	500 bytes
TL (carry time)	10 sec

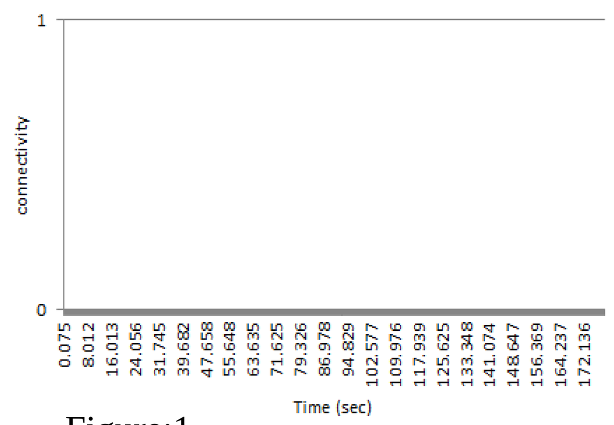


Figure:1

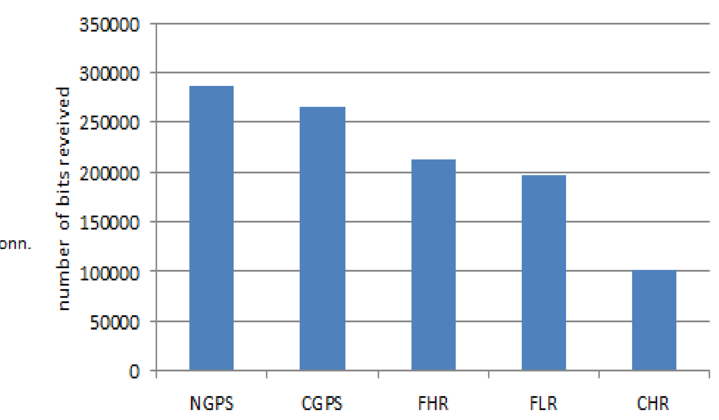


Figure:3

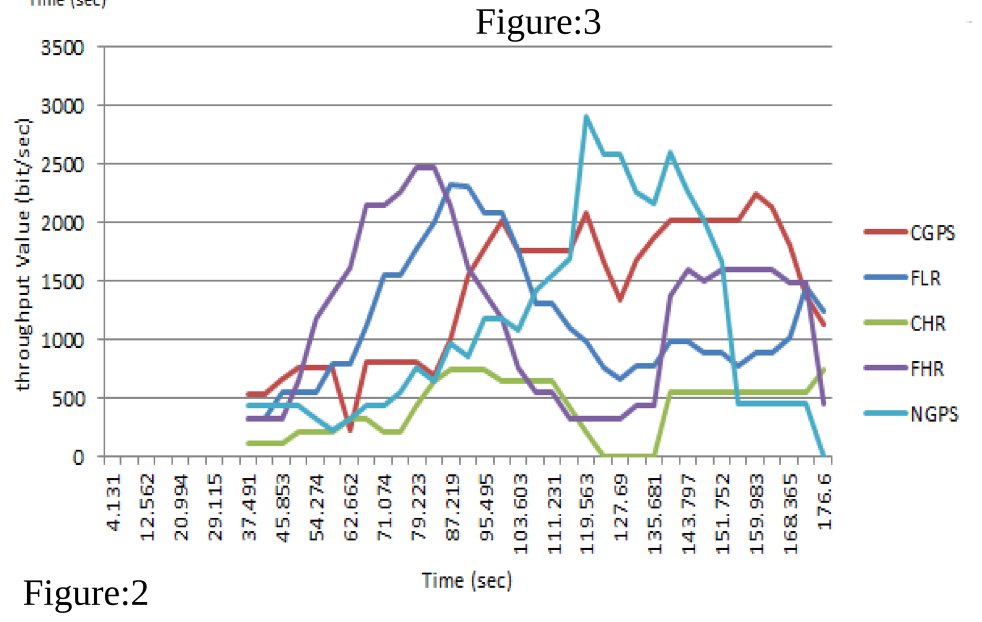


Figure:2

Figure 2 shows the throughput resulting from implementing different versions of the c-protocol. Although, there was no end-to-end path between the source and the destination, the c-protocol allowed data to go through and be delivered to the destination. GPS enabled versions, CGPS and NGPS, allow for a larger amount of data to be delivered than other versions.

Figure 3 shows the total number of bits received at the destination resulting from using different versions of c-protocol. Again, the graph shows that the GPS enabled versions have the highest delivery.

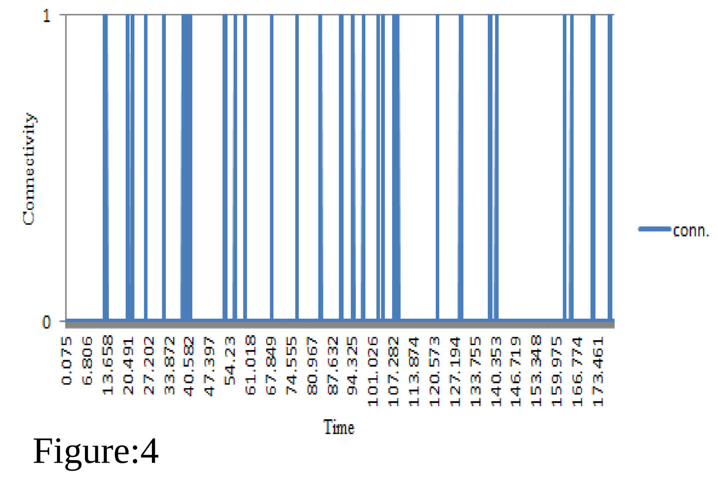


Figure:4

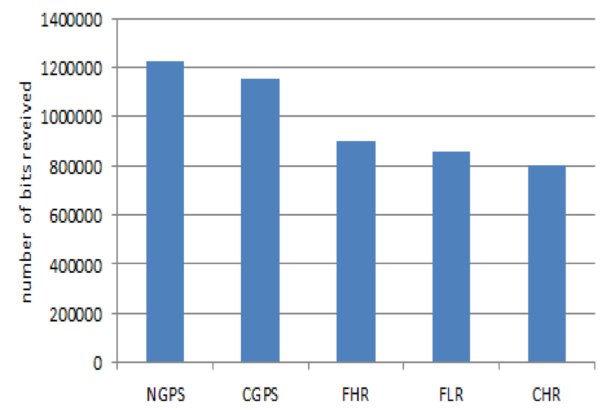


Figure:6

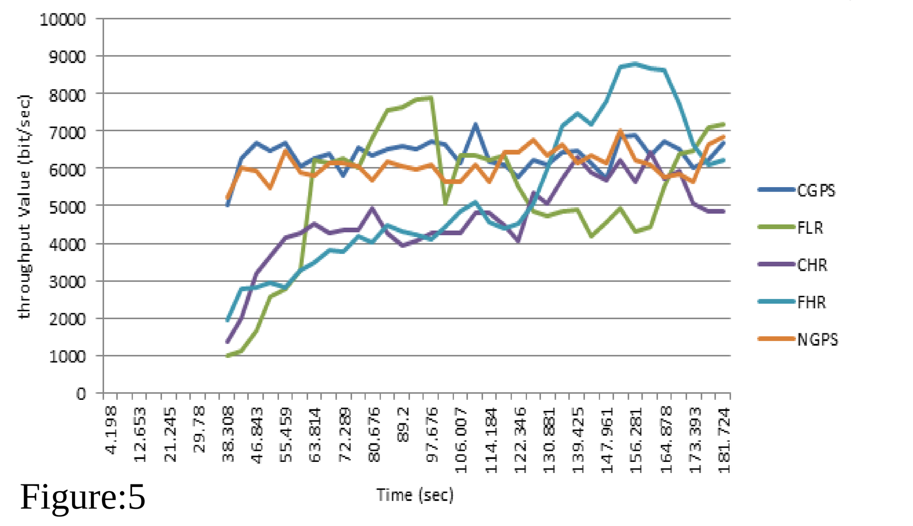


Figure:5

Figure 4 shows the end-to-end connectivity between the source and the destination in the second experiment when the number of nodes is 50 (N=50). The connectivity occurs only periodically during this experiment.

The total time of end-to-end connectivity recorded in this experiment was 63 ms. If we use 20kbps link rate we can estimate the maximum number of bits delivered over the 20kbps connection is 1260 bits. This would be the maximum throughput achievable using a conventional MANET.

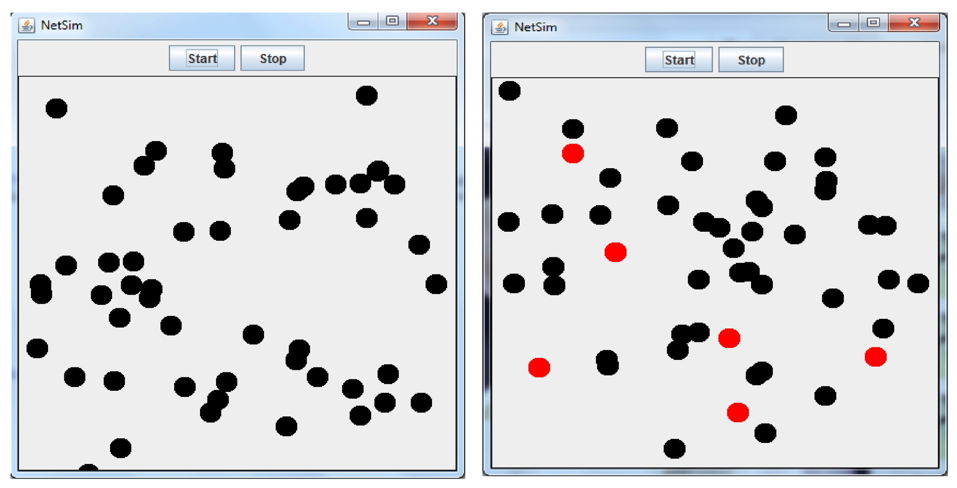
The throughput for the c-protocol is shown in figure 5. The total number of bits delivered is in figure 6. For NGPS protocol, we recorded 1,200,000 bits received in the course of the experiment.

Conclusion

Currently in MANETs, it is essential to have an end-to-end connection in order to deliver packets; without end-to-end connectivity no packets would be delivered. C-protocol addresses this problem by introducing the carry (store/forward) mechanism that allows packets to be delivered even with the absence of an end-to-end connection.

There are two different types of protocols introduced in our work. They include the c-protocols that work without the need of using GPS location of the final destination and the c-protocols that make use of such a GPS location. Both types of c-protocols reported to be able to deliver data to the destination even without end-to-end connections. The c-protocol versions that use GPS result in more throughput in the network. Furthermore, c-protocol delivers more data than a regular MANET protocol even in the presence of a sporadic end-to-end connection.

Screenshots of the simulator used.



Supervisors : John DeDourek and Przemyslaw Pochec

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