Enhancement of Cooperation Performance in Wireless Ad-Hoc Networks

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Abstract

Cooperation among nodes in an ad hoc network is essential for multi-hop communications; the source nodes are using an intermediate node as relays to communicate with far off destinations, it may not be in the best interest of nodes to always accept relay requests. On the other hand, the network throughput will drop dramatically if all nodes decide not to expend energy in relaying so non-cooperative (selfish) nodes reduce cooperation by refusing to forward packets for others. There were three strategies used to solve this problem; the Tit For Tat (TFT), Live and Let Live, and Selective Drop (SD) scenario. In this work, the cooperation had discussed in new strategy resulted from the combination of the Generous Tit For Tat (GTFT) strategy with Selective Drop strategy and we measured the throughput of this strategy and it was enhanced when compared with throughput of the GTFT. The selfishness of some nodes due to the power consumption problem solved by suggestion to selecting routes that contain few hops with low drop percentage instead of many hops with high drop percentage.

Keywords — *Ad-Hoc, GTFT, SD, Throughput, Cooperation.*

I. INTRODUCTION

An ad hoc wireless is a collection of wireless mobile nodes which dynamically forming a temporary mobile nodes which dynamically forming a temporary network with the absence of any established infrastructure of centralized administration [1]. Since there was no base station in wireless ad hoc network, each node operates as an end system and a router for all other nodes in the network [2].

One of the open problem in wireless ad hoc network is the dynamic topologies because the nodes are free to move arbitrarily; thus, the network topology - which is typically multi hop - may change randomly and rapidly at unpredictable times [3,4]. Adjustment of transmission and reception parameters such as power may also impact the topology so the nodes in a mobile ad hoc network (MANET) are energy constrained and may act selfishly refusing to cooperate in forwarding packets for other nodes [5].

Each node in wireless ad hoc network can be programmed to adopt one of the following three strategies [4,5,6]:

- Tit-for-tat: A node drops or forwards packets based on the observed behavior of its neighboring nodes. This requires the node to listen in promiscuous mode to capture the actions of its neighbors and mimic them.
- Live-and-let-live: A node implementing this strategy:

1) Reduce the node connectivity to its neighbors by keeping an active logical connection only to one of the neighbors, selected based on reachability of the remaining network nodes.
2) Adopts a monitoring mechanism to detect misbehaving neighbors and isolate them.

- Selective drop: A node implementing this strategy drops a fixed percentage of packets (which can be set between 0-100%) that it is asked to forward. A node maintains a list of destination nodes and their respective drop percentages.

The selection of these strategies includes both simple, static strategies (selective drop) and dynamic ones (tit-for-tat and live-and-let-live). These strategies represent a subset of those implemented by teams competing in the 2007 MANIAC Challenge. They quantify the effect of these strategies on both real time and non-real time traffic. The performance is reflected in terms of throughput and packet delivery ratio for non-real time data and timeliness of packet delivery for real time data.

In this work, a new cooperation strategy is proposed, this strategy is based on others two strategies for cooperation; GTFT and SD. The new strategy is a static-dynamic scenario; according to the selective drop strategy, each node in the network has a dropping table for its neighbours so when a source node wants to send a number of packets then it sends a request to its neighbour that has a small percentage of drop because node with small percentage of drop will forward large number of packets and this is done according to the GTFT strategy, each node keeps a connection with the behaviour nodes (i.e. nodes have low drop percentage).

This work deals with energy efficiency and throughput in multi hop ad hoc wireless networks. It assumes that each node generates traffic for some other node in the network and that the available routes between each source-destination pair are known. Each source selects one of the possible routes- according to the strategy proposed in this project- and asks the intermediate nodes on the route to relay traffic. Since energy is a valuable resource, intermediate nodes may not wish to consume their energy to carry the source's traffic. This work tries to enhance the throughput of the network and solve the selfishness of nodes due to power consumption by suggest a new cooperation strategy resulted from the combination of the GTFT strategy with the SD strategy. The problem of non-cooperative nodes has been addressed previously in [2, 5]. In [6], the node behaviour and their performance were enhanced by viewed the non-cooperative nodes as malicious and suggest methods to identify misbehaving users and to avoid routing through these nodes. In [7], the selfishness problem solved by enhanced the tit for tat strategy to a gift tit for tat strategy (GTFT). In [8], a simple mechanism is proposed, this mechanism makes source nodes give as many battery units as the estimated number of nodes on the route path to the destination, and relay nodes in this mechanism earn as many battery units as the number of forwarded packets.

The rest of this paper is organized as follows: section 2 contains the modelling of new cooperation strategy, section 3, section 3.1, and section 3.2 show the simulation results, and the overall paper is concluded in section 4.

II. MODELING OF THE NEW COOPERATION STRATEGY

The new proposed cooperation is "hybrid" (i.e. static-dynamic) strategy composed of the GTFT strategy and SD strategy. It defines initially the source, destination, and the relay nodes; here, suppose that the relay nodes are known; then a special target node is defined to present the new hybrid cooperation strategy. The behaviour of the proposed cooperation model is presented by a flow chart shown in Fig. 1. First initialize the selective drop percentage for each node and create the selective drop table. In this paper the SD percentages are assumed and inserted into a MATLAB function. Choose the relay node or nodes according to the selective drop percentage, in this paper, the minimum taken percentage is equal to 50 (i.e. the maximum rate of dropping packet must not exceed 50% so relay node should drop 50% of the packet and forward 50% at least). After finding the destination (its location is proposed), the relay node will send the packets with a fixed percentage as explained above. If the packets that the source wish to send are completely send, the transmission operation is done or the source node return to find another relay to send the remaining packets. The new hybrid strategy assumes that there are four nodes between to the destination including the source node, the source wishes to transmit 1000 packets with power consumptions of the four nodes (n_1, n_2, n_3, n_4) are: 90%, 50%, 65%, and 70% respectively as shown in Fig. 2. The power needs to send one packet for the source is 0.0008.

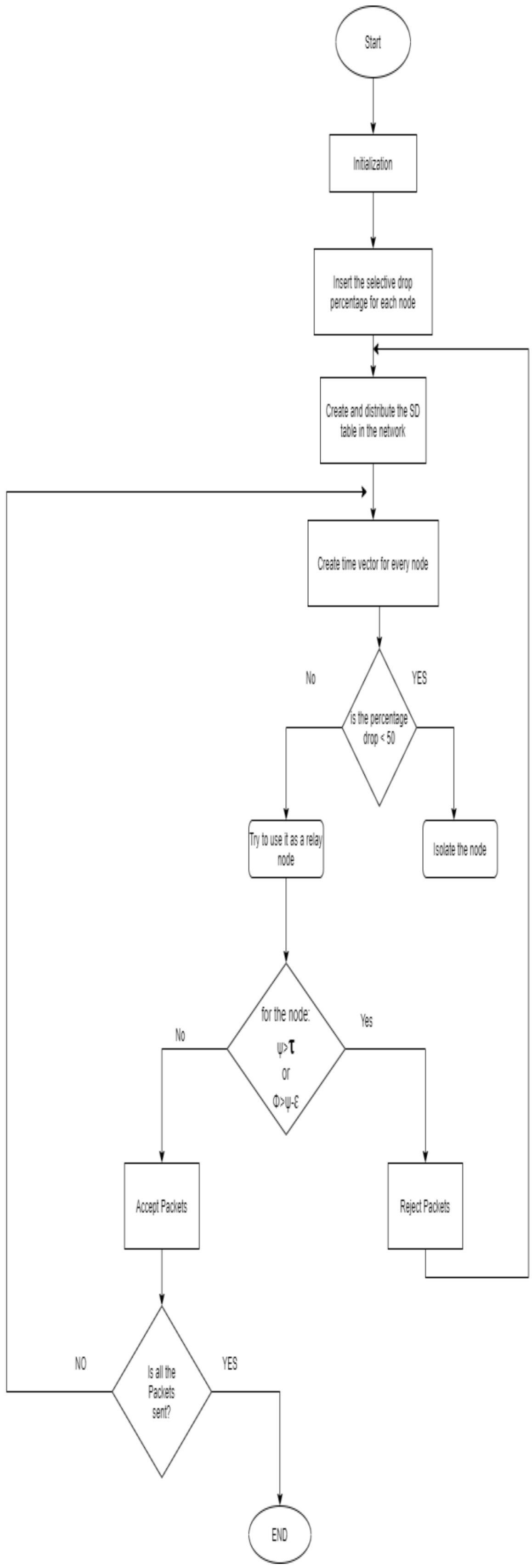

Fig. 1: Proposed Cooperation Model.

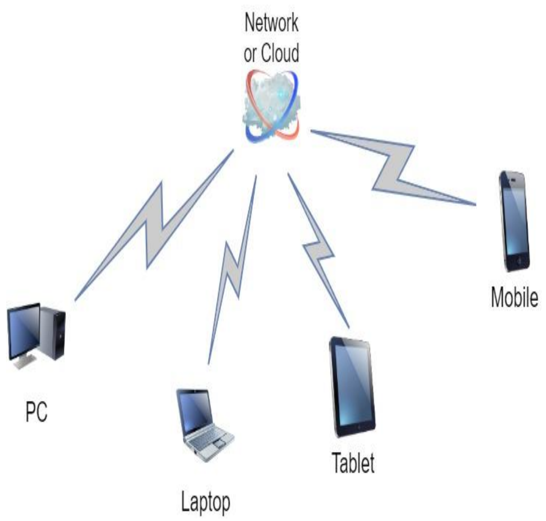

Fig. 2: Selective Drop Tables.

III. Simulation Results

In this work, a comparison makes between the GTFT strategy and the new hybrid strategy. Since the behaviour of the nodes in the new cooperation strategy is like the behaviour of nodes in GTFT strategy, the proposed project programmed the new strategy in a way that the throughput of the network increased more than the throughput in GTFT algorithm. The simulation has been building on the assumption that the selective drop table of the nodes was derived from the percentage of the power consumption; each node drops a percentage of packets and forwards a fixed percentage of packets according to its own power capability. And as shown in Fig. 2, the 1st node ($node_1$) was supposed to be a PC with 90% power consumption, $node_2$ is supposed as a Laptop with 50% power consumption, $node_3$ supposed to be a tablet with 65% power consumption, and $node_4$ is as a mobile device with power consumption equal to 70%.

A. Tit for Tat Simulation Results

From figures (3-a), (3-b), (3-c) and (3-d) shown below the behaviour of the nodes could be seen by plotting their throughputs, Φ which is relationship between the (number of relay requested packets accepted by the nodes) with (number of relayed requested packets generated by the nodes), and ψ which is the relationship between the (number of relay requested accepted to the nodes) with (number of relayed requested made to the nodes). Note that as the number of packets that the source wants to emit increased, the throughput decreased due to power constraint. It is clear from the figures below that the node first starts sending packets with high percentage but after a fixed number of transmitting packets, the node starts dropping packets. Also, it is clear that as the number of requested packets increased, the amount of sent packet is increased too. And notes that the total throughput in tit for tat strategy increased if and only if the grade of generosity increased the power consumption does not matter and this case happened but with a small probability because not all nodes will accept to forward the other nodes packets without taking the power consumption into account.

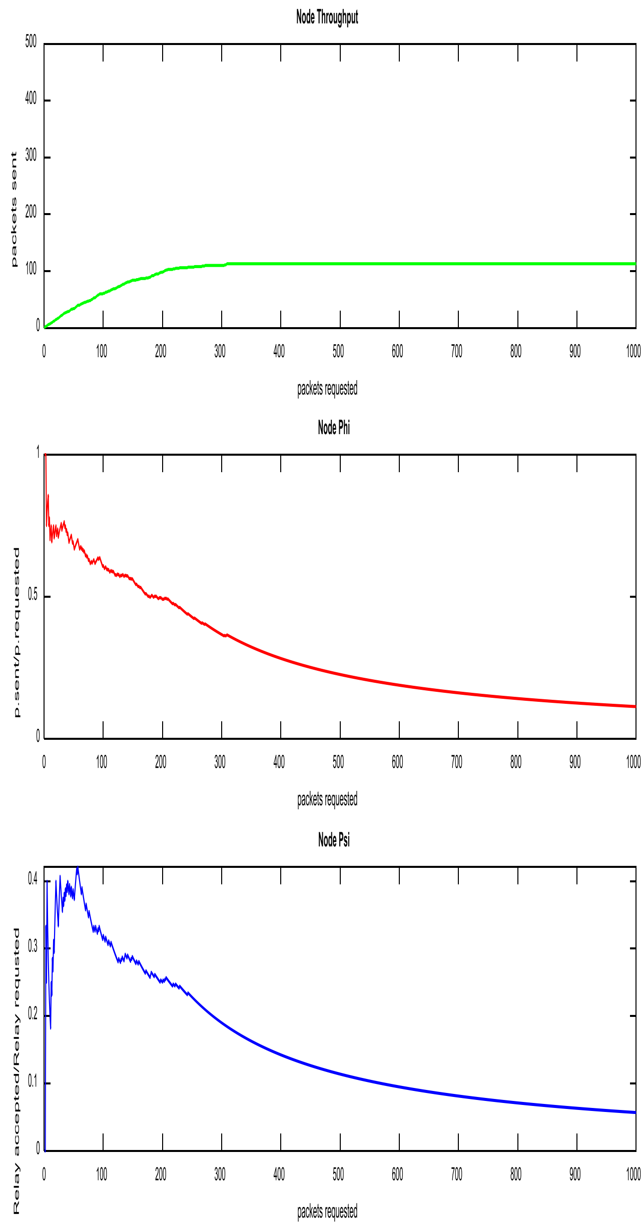

Fig. (3-a): TFT $Node_1$ Performance.

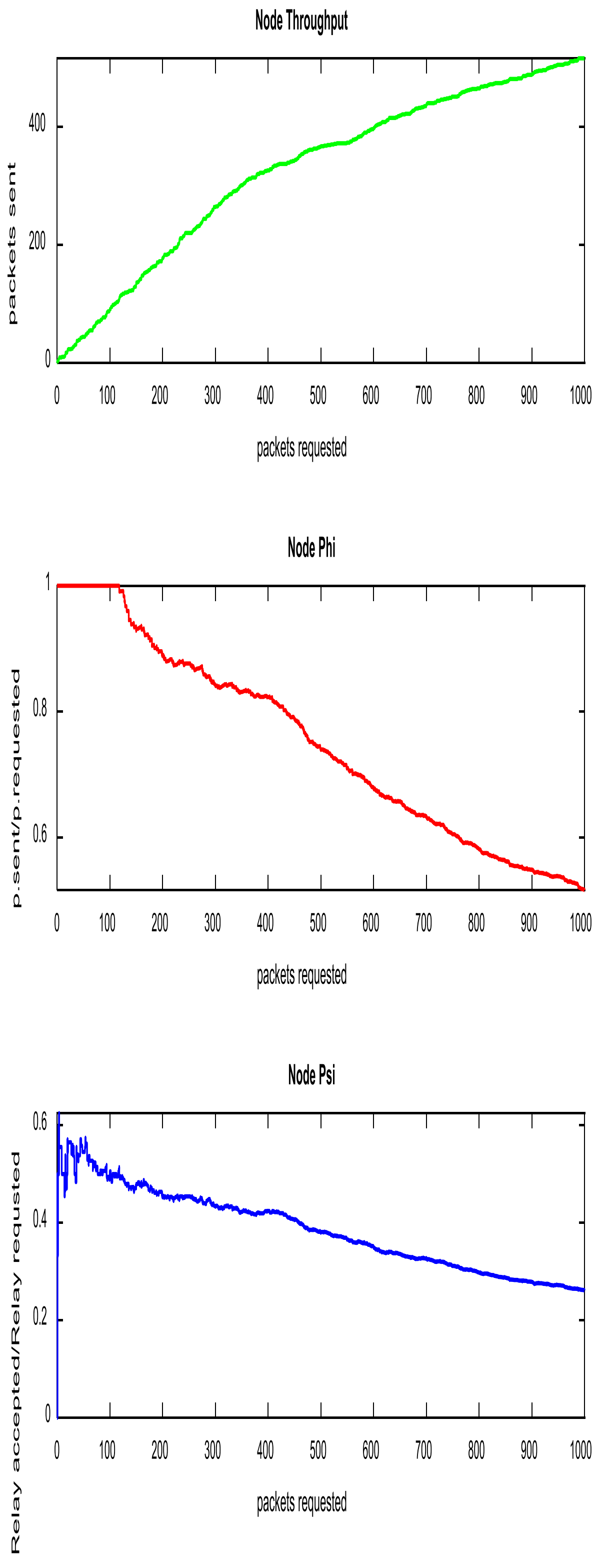

Fig. (3-b): TFT Node$_2$ Performance.

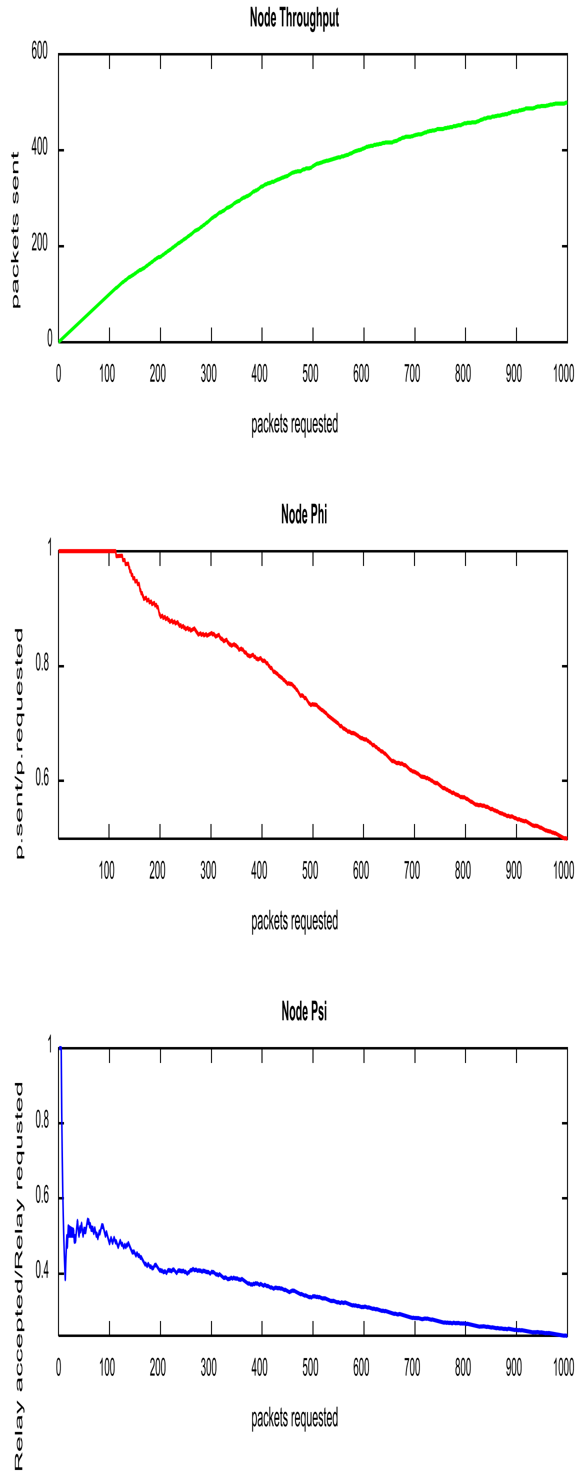

Fig. (3-c): TFT Node$_3$ Performance.

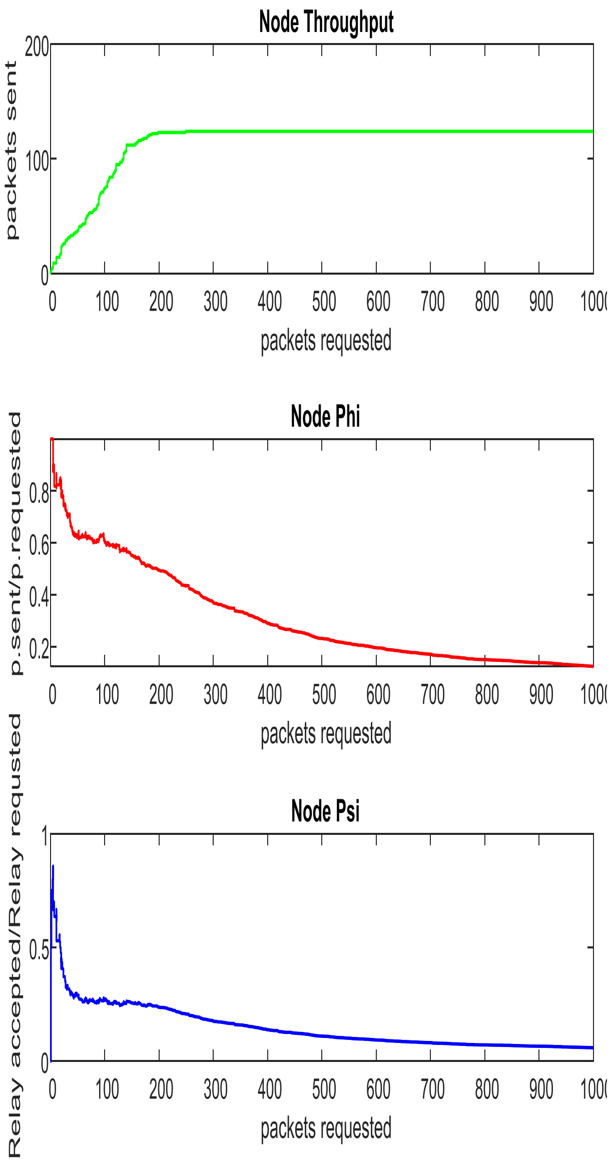

Fig. (3-d): TFT Node$_4$ Performance.

B. Proposed Static-Dynamic Cooperation Simulation Results

Since the power consumption is taking into account of the node calculations, the node forwards the packets according to the selective drop table, for example node 1 has percentage drop with 10% so it drops 10 packets from each 100 packets and forwards 90 packets from each 100 packets. The relay node should be dropping small number of packets; in this example, the relay node is node$_4$ because it has the smallest drop percentage which is 30%, so the throughput will be increased always. Figures (4-a), (4-b), (4-c) and (4-d) are showing the throughput of nodes 1, 2, 3 and 4. The total throughput of new hybrid cooperation strategy is refluxing the whole network throughput. The new strategy has an increasing throughput because each node sends a fixed percentage unlike the tit for tat node which has no choice, either forwarding all the packets for the source and this will consume the node power or refusing to send the packets and this will reduce the network performance due to the reduction in throughput. Figures (5-a), (5-b), (5-c) and (5-d) are showing a comparison between the total throughput of the new static-dynamic and traditional GTFT cooperation strategies.

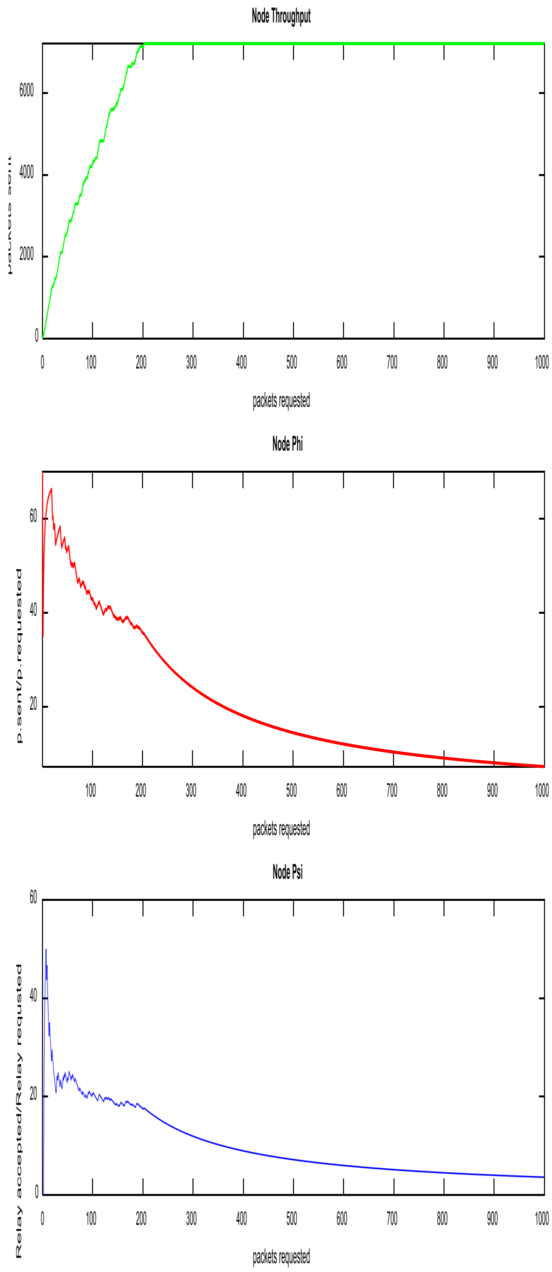

Fig. (4-a): New Static-Dynamic Node$_1$ Performance.

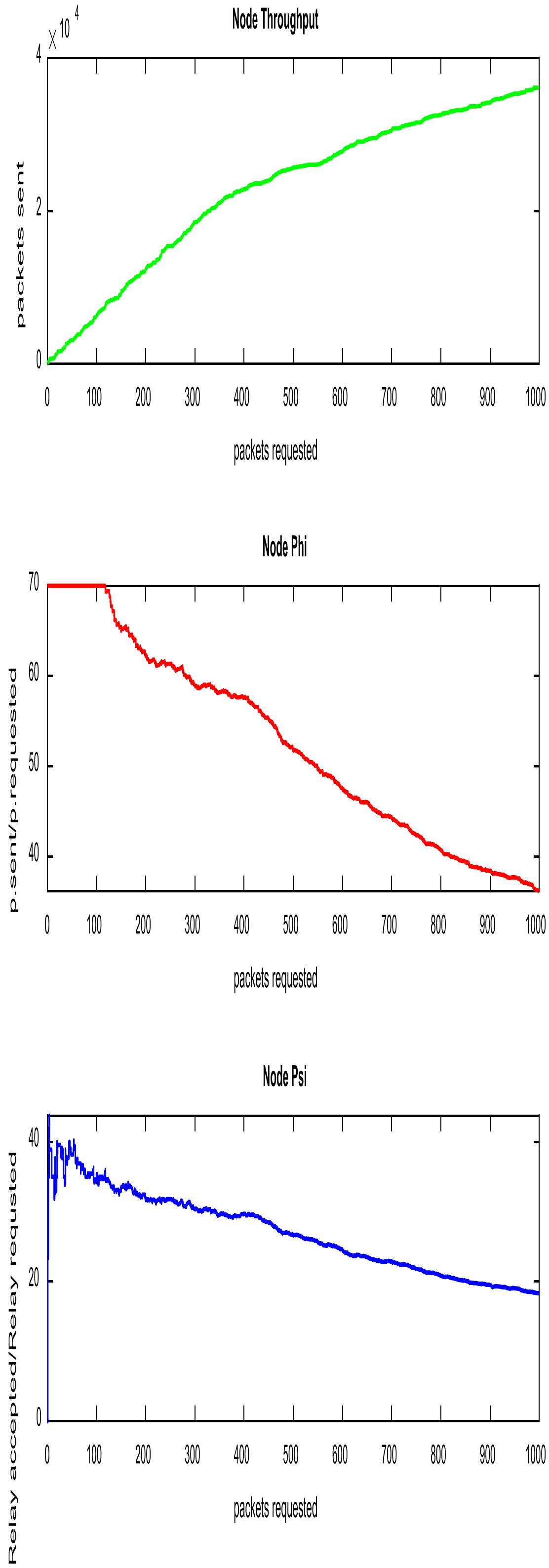

Fig. (4-b): New Static-Dynamic Node$_2$

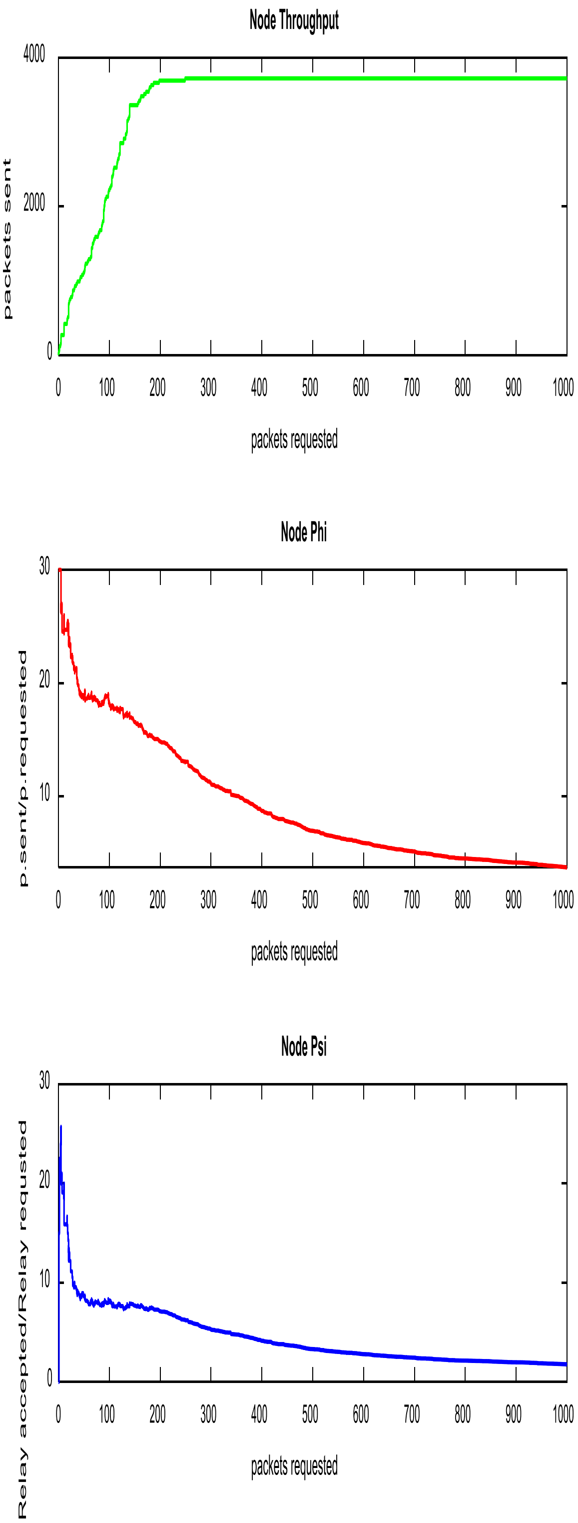

Fig. (4-c): New Static-Dynamic Node$_3$ Performance.

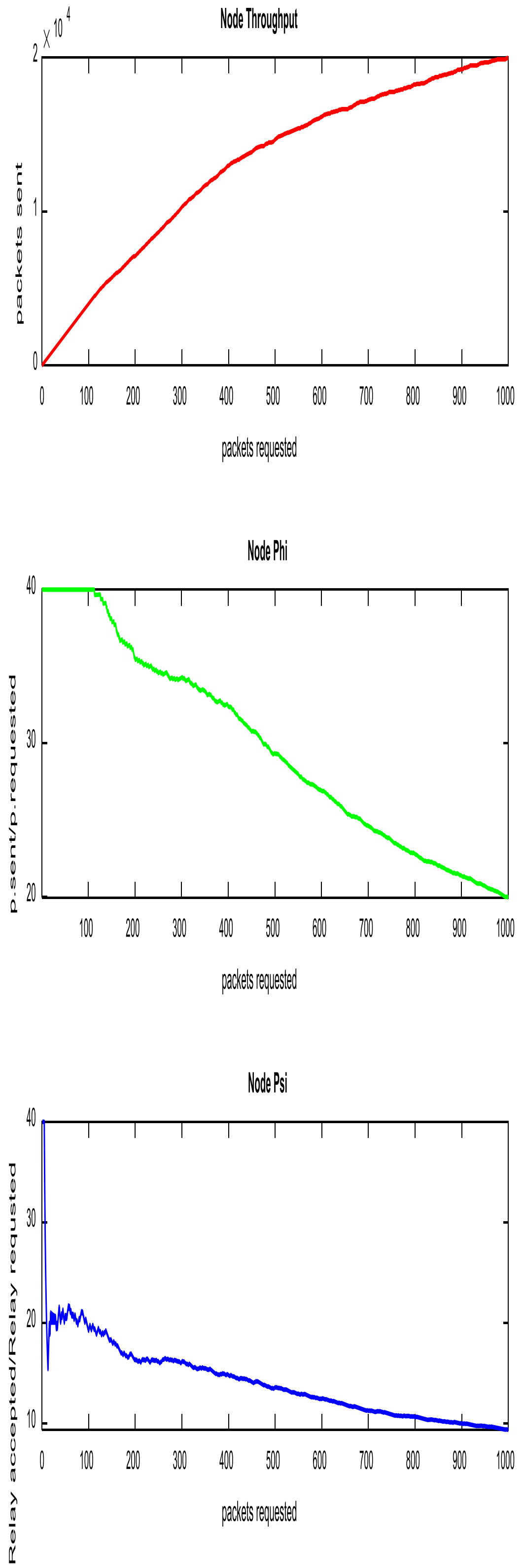

Fig. (4-d): New Static-Dynamic Node$_4$ Performance.

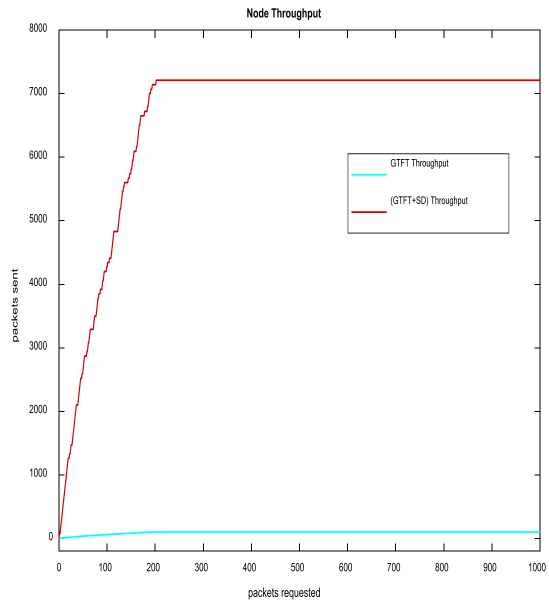

Fig. (5-a): Throughput Comparison of Node$_1$

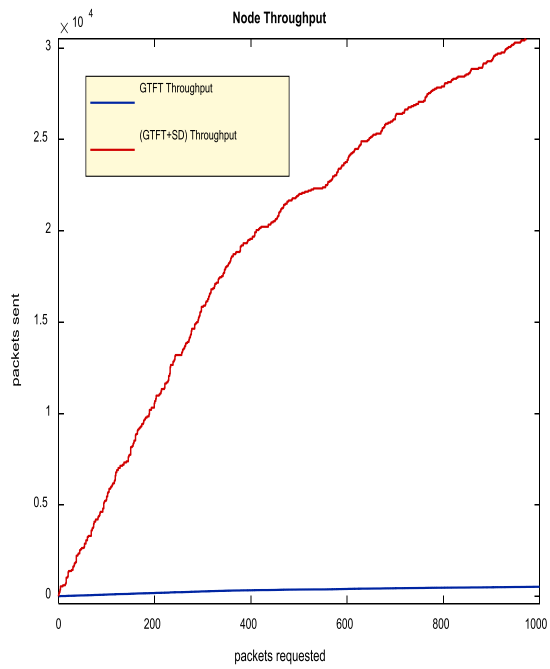

Fig. (5-b): Throughput Comparison of Node$_2$

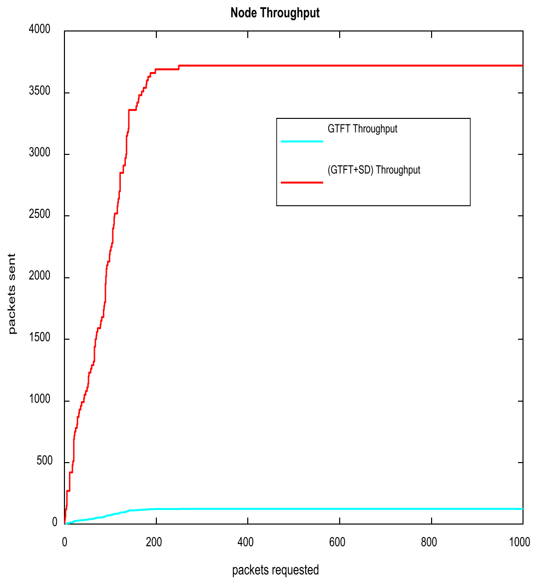

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Fig. (5-c): Throughput Comparison of Node$_3$.

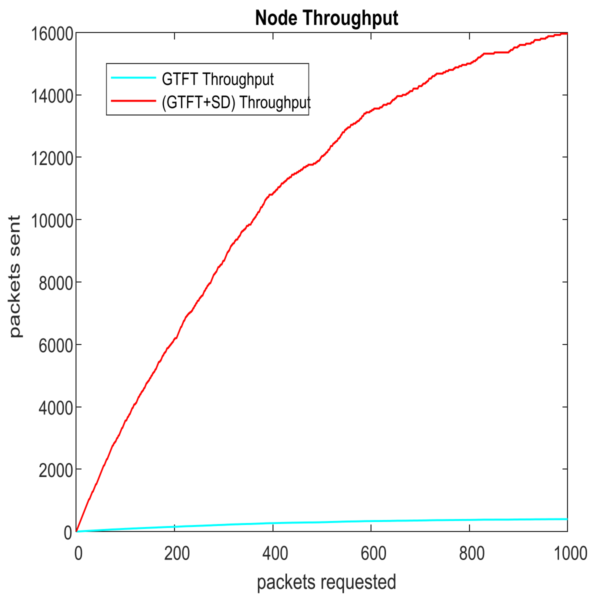

Fig. (5-d): Throughput Comparison of Node$_4$.

IV. Concluded Remarks

In this work, the combination of the two known cooperation strategies are emerged in order to get a new cooperation strategy called new static-dynamic strategy. This new strategy combines the GTFT strategy with the SD strategy so that it can keep the power consumption as low as possible with complete network end-to-end reachability and maximum possible throughput to be achieved without risking high packet drop. The simulation results showed the throughput for each node separately and the whole network throughput measured using the new proposed strategy is better than other existed strategies such as TFT. Also the proposed strategy solved the selfishness problem of some nodes due to the power consumption, since the new strategy suggested to select routes that contain few hops with low drop percentage instead of many hops with high drop percentage.

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