International Journal on Recent and Innovation Trends in Computing and Communication
Volume: 5 Issue: 7
ISSN: 2321-8169
642 – 647

ANFIS Based Temporally Ordered Routing Algorithm to Enhance the Performance in Mobile Ad-hoc Networks

C.R.Raman
Dept. of CS&SE
Andhra University
Visakhapatnam, AP, India
raman_6858@yahoo.com

Dr.S.Pallam Setty
Dept. of CS&SE
Andhra University
Visakhapatnam, AP, India
drspsetty @gmail.com

Abstract— A Mobile Ad hoc network (MANET) consists of mobile nodes, a router with multiple hosts and wireless communication devices. Mobile Adhoc Networks can operate without any fixed infrastructure and can survive rapid changes in the network topology. Link failure and route failure takes place. Provisioning of QoS is a problem in MANETs. TORA is the only protocol which supports either Proactive or Reactive modes in routing. In this paper, we incorporated the ANFIS to the existing TORA to enhance the performance. Evaluating the performance of ANFIS-TORA is the simulation by using OPNET MODELLER. Evaluating the relative performance with respect to performance metrics are Throughput, End-to-End delay, and Network Load. We generate various simulation scenarios with varying network size such as small, medium and large. In this paper, ANFIS based TORA for MANETs are considered and their performance was analyzed for different network size. From the simulation results, we conclude that ANFIS based TORA outperforms for small medium and large network. Throughput was increased by 48.27% in small network, 61.29% in medium network and 8.29% in the large network in Reactive mode. In Proactive, the throughput is increased by 103.46% in small network, 4.58% in medium network and 5.05% in large network.

Keywords- *MANET, TORA, Proactive, Reactive, ANFIS-TORA*

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I. INTRODUCTION

The emergence of wireless networks has gone a long way in solving the growing service demands. The focus of research and development endeavour has almost shifted from wired networks to wireless networks. The limitations of wireless network techniques such as power restrictions high error rate, bandwidth limitations and other constraints have not lead to the growth of wireless networks. Mobile Ad-hoc network (MANET) is one of the most demanding fields in the area of the wireless network. MANET [1][2][3] consists of mobile devices or users which are generally known as nodes, and each one of nodes which are equipped with a radio transceiver. MANET is a temporary network of wireless mobile nodes which have no fixed infrastructure. There are no dedicated routers, servers, access points, base stations, and cables. The mobile nodes which are within each other's transmission range can communicate with each other directly; or else, other nodes in between can forward the packets if the source and the destination node are ―out of each other's range. Every node acts as a router to forward the packets to other nodes whenever required [4]. Mobile ad-hoc network is ―infrastructure-less networks having nodes which can act as a transmitter, router or receiver [5]. MANETs have a dynamic topology where nodes are mobile [11]. To monitor the workings of these nodes and the nature in which they behave while sending, receiving or forwarding data is classified by a set of rules known as routing protocols [6].As the organization of the paper is organized as follows, Section I contains the introduction of MANETs, Section II explains Temporally Ordered Routing Algorithm, Section III explains the methodology, Section IV explains simulation environment, section V explain the performance, Section VI describes results and conclusion.

II. TEMPORALLY ORDERED ROUTING ALGORITHM

TORA is an adaptive routing protocol for multi-hop networks that include the following attribute:

* Distributed execution,
* Loop-free routing,
* Multipath routing,
* Reactive or proactive route establishment and maintenance, and
* Minimization of communication overhead via localization of algorithmic reaction to topological changes.

TORA [7] is distributed, in that routers need only maintain information about adjacent routers (i.e., one-hop knowledge). TORA maintains state on a per-destination basis like a distance vector routing approach. However, TORA does not continuously execute a shortest-path computation and thus the metric used to establish the routing structure does not represent a distance. The destination-oriented nature of the routing structure in TORA supports either reactive or proactive routing on a per-destination basis. During reactive operation, sources initiate the establishment of routes to a given destination on-demand. This mode of operation may be advantageous in a dynamic environment with relatively sparse traffic patterns, since it may not be necessary to maintain routes between every source/destination pair at all times. Concurrently selected destinations can initiate proactive operation, resembling traditional table-driven routing approaches. This allows routes to be proactively maintained to destinations for which routing is frequently required.

III. METHODOLOGY

ANFIS [8][9] derives its name from Adaptive Neuro-fuzzy inference system ANFIS constructs a fuzzy inference system (FIS) whose membership function parameters are tuned (adjusted) using either a back propagation algorithm alone or in combination with a least squares type of method. The idea behind ANFIS is to design a system that utilizes a fuzzy system to represent the knowledge and use the learning ability of a neural network to adjust membership function parameters and linguistic rules directly from data in order to improve system performance. The ANFIS [10] is used in many fields namely medicine, manufacturing, industrial, forecasting, delay prediction in communication networks, decision making, signal processing and 43 controllers, pattern recognition and neurological decisions. Therefore, ANFIS may be incorporated in TORA routing protocol to check the suitability for various network sizes. TORA considers the defaults constants in the dynamic environment. The proposed method concentrates on the Beacon Period value which plays an important role in calculating dynamic environment, the attribute which specifies how often the Beacon Packet will be sent out to the neighbor. The TORA suggests that the BP value should be constant but does not mention how this value should be adjusted with network size. The proposed method" ANFIS Based TORA (ANFIS-TORA)" suggests that the Beacon Period should be a suitable value with the Network size. The dynamic value of beacon period is calculated by using ANFIS by taking network size and mobility as inputs. We implemented ANFIS-TORA protocol to enhance the scalability of TORA routing protocol by using OPNET simulator.

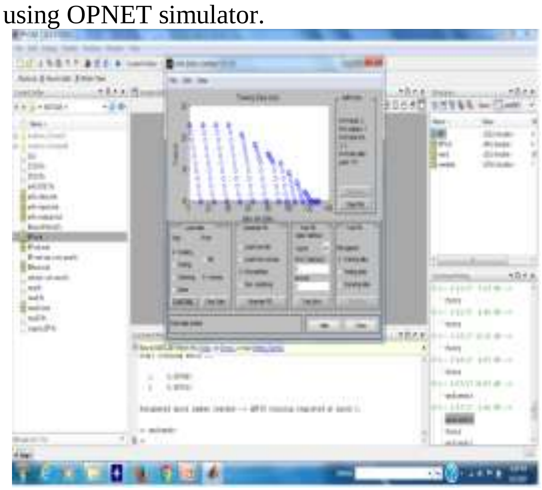

Figure: Loading data in ANFIS

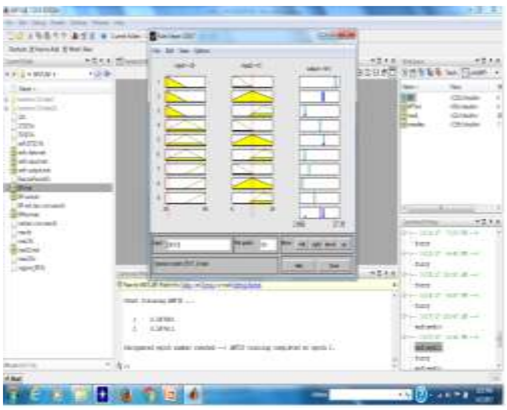

Figure: rule view in ANFIS

IV. SIMULATION ENVIRONMENT

Simulators like NS2, Glomosim, Opnet, and Qualnet etc., were developed to evaluate the performance of routing protocols. The experiments for evaluating the ANFIS-TORA model were implemented using the OPNET. OPNET [12] is a network simulator that provides virtual network communication environment. It is prominent for the research studies, network modelling and engineering, R & D Operation and performance analysis. It is extensive and powerful simulation software with a wide variety of possibilities and Enables the possibility to simulate entire heterogeneous networks with various protocols. The simulation parameters used in the method was given in the table below.

ROUTING PROTOCOL	TORA
Area	1000m x 1000m
Nodes	30,60,90
Nodes Placement	Random
Mobility Model	Random Way Point
Node Transmission Power	0.005mw
Operational mode	802.11b
Data rate	11Mbps
Simulation time	300 sec
Routing mode of operation	Proactive, Reactive

Table1: Parametric Values for TORA

V. PERFORMANCE METRICS

Throughput: Throughput means the rate or a number of successful data packets obtained at the receiver end from the source node to destination node involving a communication channel or network. So the higher throughput value means greater outcomes. Generally, throughput is determined in bits per seconds (bits/sec).

End to End Delay: End-to-end delay is referred as the amount of time taken by the packet to reach the destination from the source node.

Network load: Network load represents the total load in bit/sec submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network.

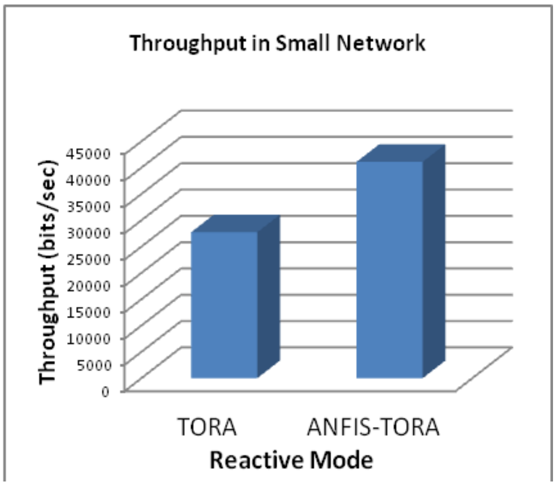

Figure 3: Throughput for Small network in Reactive mode

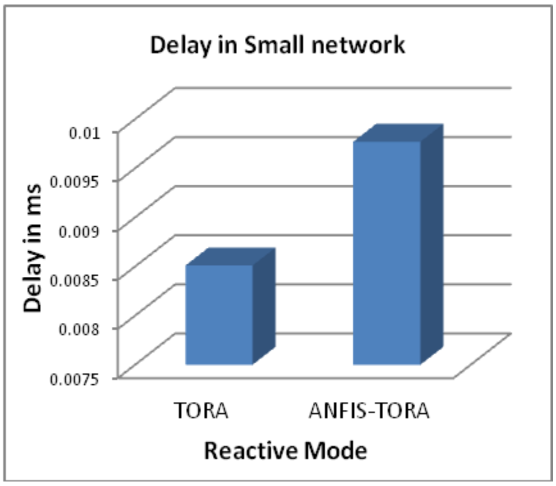

Figure 4: Delay for Small network in Reactive mode

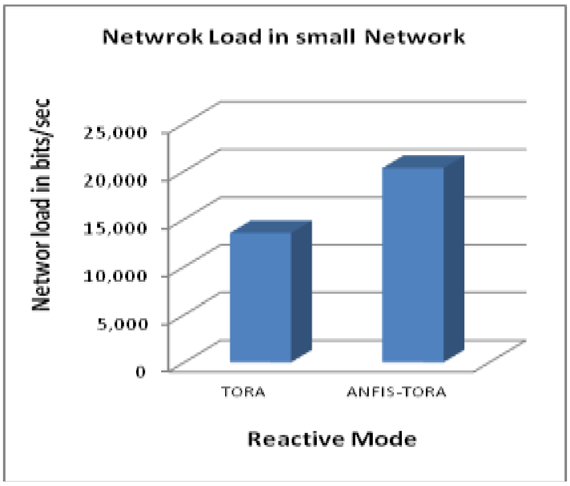

Figure 5: Network Load for Small network in Reactive mode

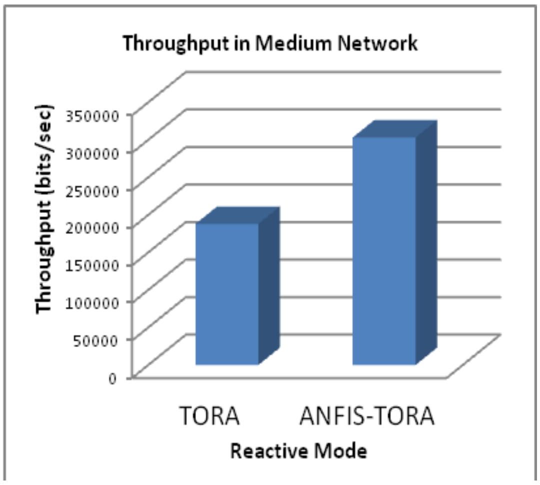

Figure 6: Throughput for Medium network in Reactive mode

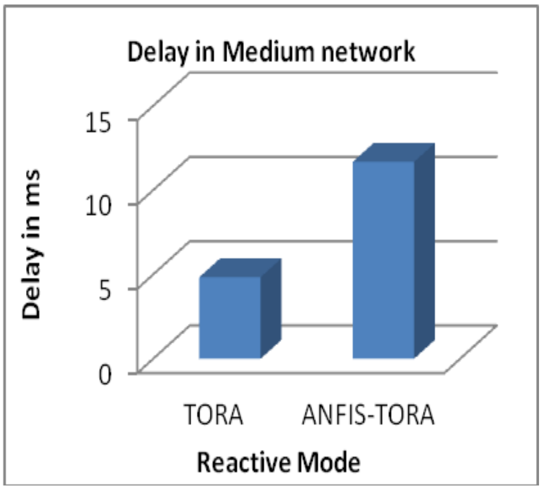

Figure 7: Delay for Medium network in Reactive mode

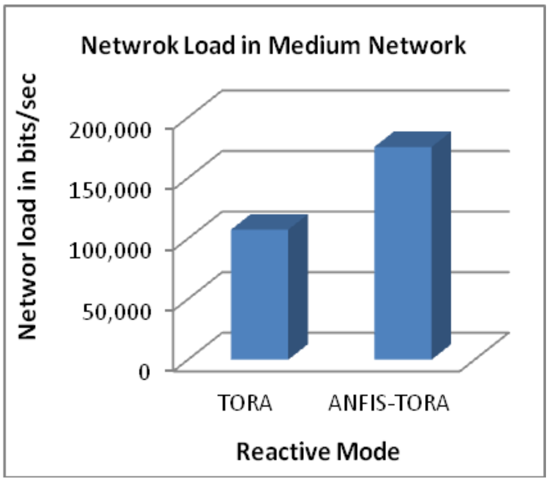

Figure 8: Network Load for Medium network in Reactive mode

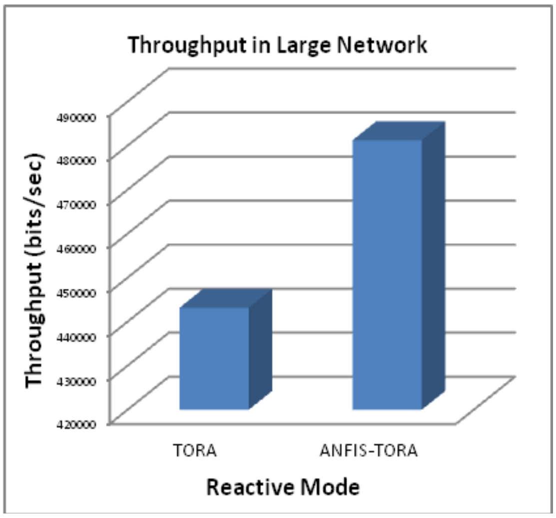

Figure 9: Throughput for Large network in Reactive mode

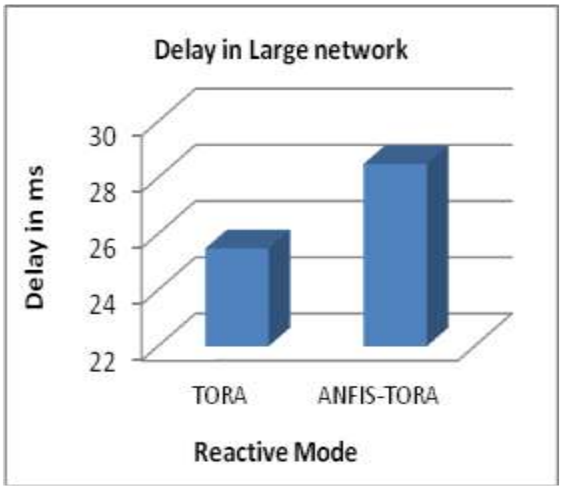

Figure 10: Delay for Medium network in Reactive mode

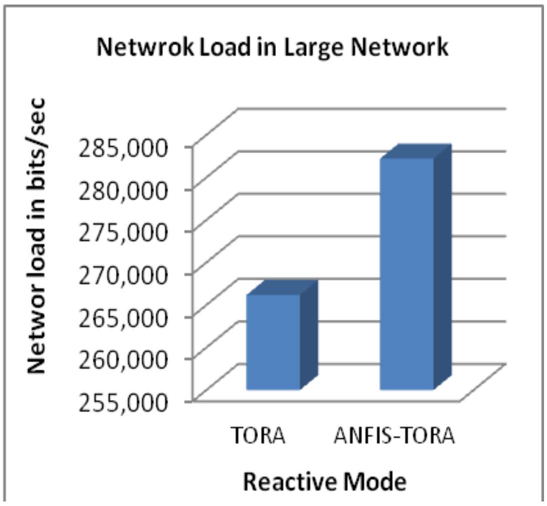

Figure 11: Network Load for Large network in Reactive model

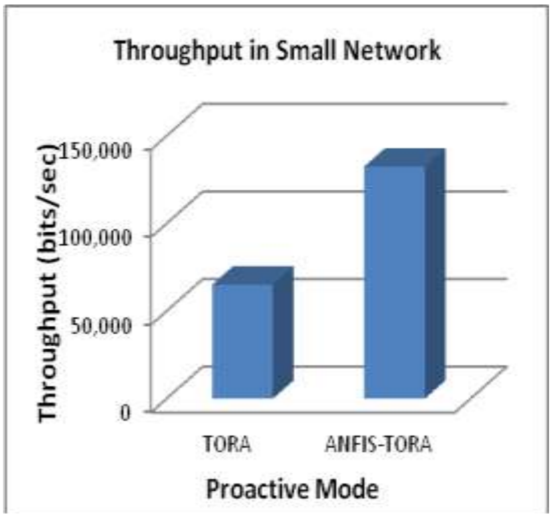

Figure 12: Throughput for Small network in Proactive mode

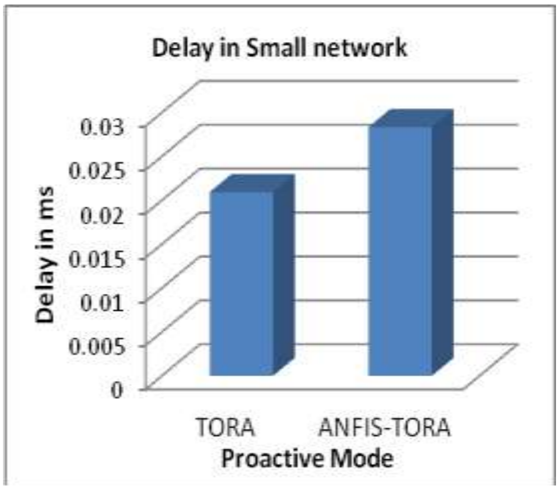

Figure 13: Delay for Small network in Proactive mode

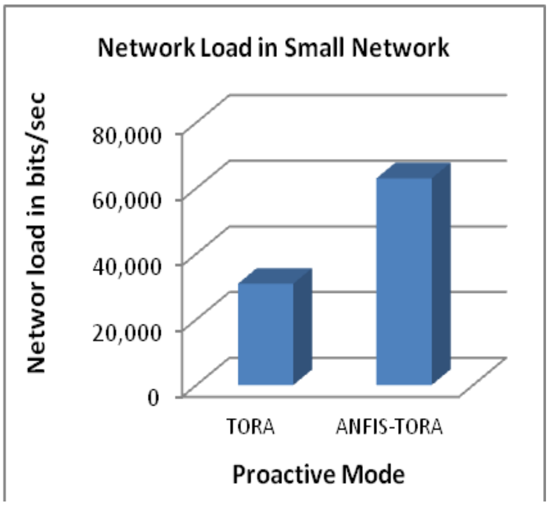

Figure 14: Network Load for Large network in Proactive model

ISSN: 2321-8169
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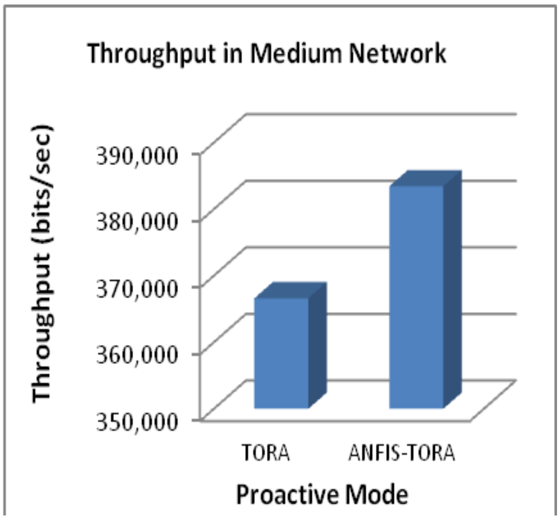

Figure 15: Throughput for Medium network in Proactive mode

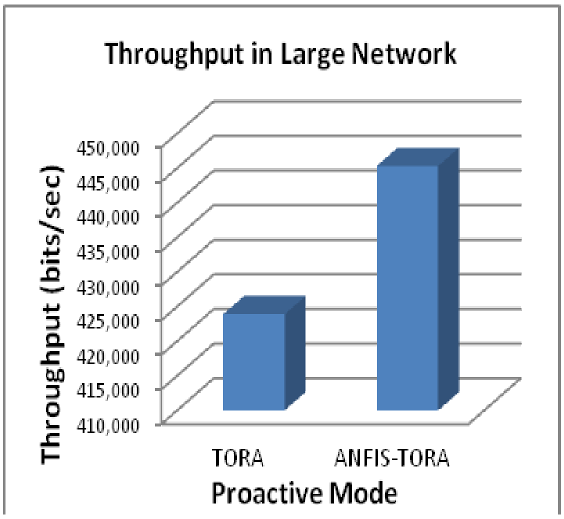

Figure 18: Throughput for Large network in Proactive mode

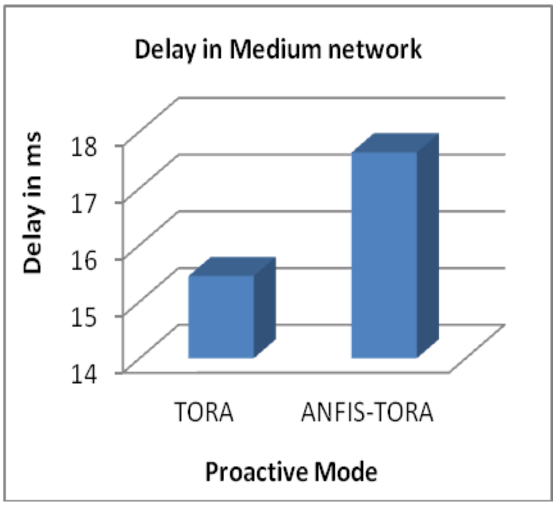

Figure 16: Delay for Medium network in Proactive mode

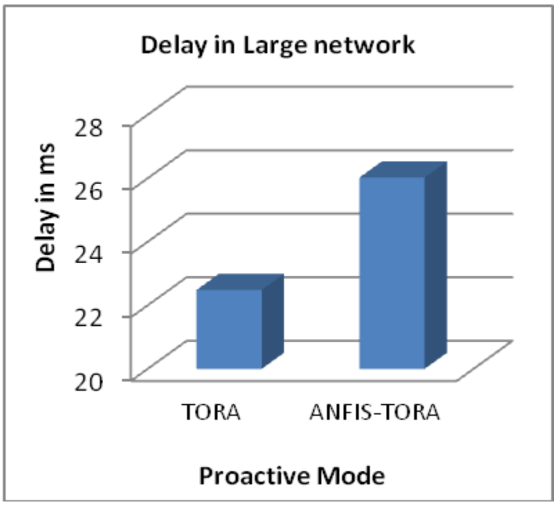

Figure 19: Delay for Large network in Proactive mode

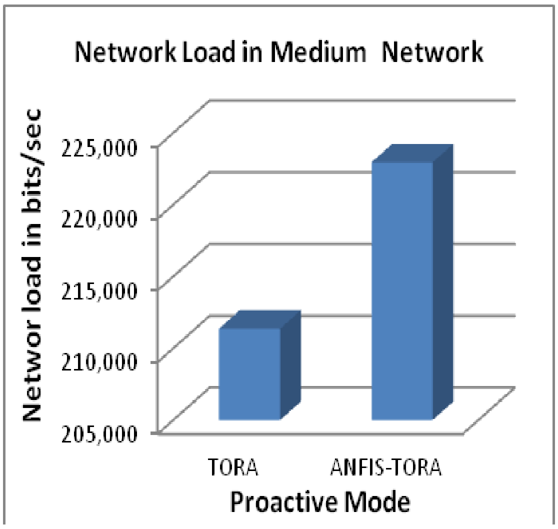

Figure 17: Network Load for Medium network in Proactive model

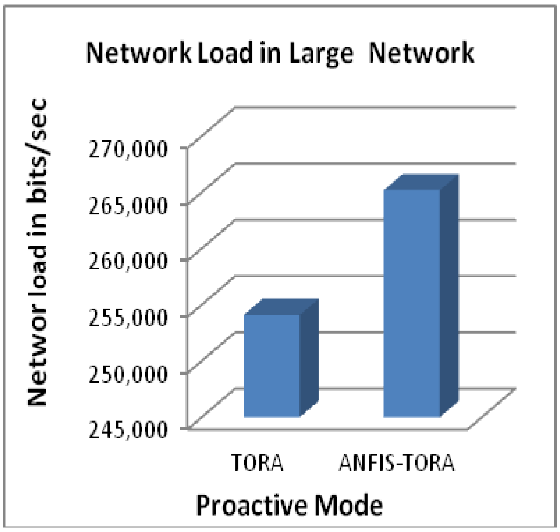

Figure 20: Network Load for Large network in Proactive model

VI. CONCLUSION

ANFIS based TORA outperforms for Small, Medium, Large networks when compared to TORA in Reactive Mode and in Proactive Mode.

Throughput was increased by 48.27% in small network, 61.29 in the medium network, 8.59% in the larger network when compared with de-facto TORA in Reactive Mode.

Throughput was increased by 103.46% in small network, 4.58% in medium network, 5.05% in the larger network when compared with de-facto TORA in Proactive Mode.

In future, this paper can be enhanced for real time applications.

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