Simulation Based Analysis of VOIP over MANET

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***Abstract*— In the last decade, Mobile Ad hoc Network (MANET) routing protocols studies have concentrated more on proactive routing protocols with various specifics to data traffic. Only some works have covered the issues of reactive protocols endorsing voice application. This research work examines the VoIP application performance in MANET set up with Temporary Ordered Routing Algorithm (TORA) routing protocol as on-demand routing protocol. The VoIP application is measured by employing four different parameters i.e. MAC protocol, codec, node density and mobility by using OPNET Simulator. The quality of transmission was evaluated by employing different performance metrics i.e. Mean Opinion Score (MOS), jitter, throughput and end-to-end delay. Results indicate that major metrics that had high effect on the network performance involving node density and mobility. This research showed that communication in an ad hoc network utilizing TORA is more effective and productive and effective with less nodes.**

Keywords: VoIP over MANET, On-demand Routing Protocol, VoIP Traffic Optimization, Mobile Ad Hoc Networks.

I. Introduction

MANET is set of mobile nodes that can interact with each other without the use of pre-specified infrastructure or centralized management [2]. Every node in the setup behaves both as a router and as a host; propagating messages to another nodes that are not in radio range [4].

There are many characteristics of mobile ad-hoc network which differentiate from the wired network. These involve bandwidth constraint, dynamic topology, energy constraint operation, variable capacity link, and restricted physical security. Various protocols have been utilized to examine these features and compare it with the routing protocols in wired connection for predicting these variations. In a VoIP system some kind of mechanisms is needed i.e. noise cancellation, voice digitalization, and voice compression for the operation to be executed [6]. Given the growing trend towards Voice-over-Internet Protocol (VoIP) with its predicting paybacks, this discussion examines the voice application performance in a wireless mobile ad hoc network utilizing Temporary Ordered Routing Algorithm (TORA);

The light is beamed on Temporary-Ordered Routing Algorithm (TORA) to examine the voice communication (traffic) performance in Mobile Ad-hoc Network (MANET) related to efficiency, energy conservation, packet drop and quality of service. Some work have been done already on the problems of duplicate address detection, merging, security and scalability breaches, even higher works have been done on normal routing protocols performance. The selection of TORA is communicated by its suitability for MANET protocols particularly in heavy population of nodes [4], its capability to keep multiple routes from source node to destination node even with quick configuration changes. While examining the performances of various popular routing protocols for VoIP application in MANET, TORA routing protocol performs the best candidate in comparison of other protocols [8]. The performance of TORA as a reactive-dominated and hybrid protocol will be examined against famous performance metrics (parameters).

II. Related Works

Mobile Ad-Hoc Network (MANET) explains a quick deployment of communication channels among nodes in a temporary surrounding without third-party physical infrastructure. Information routing among nodes is based on the neighboring nodes that are invariably in motion, keeping a dynamic configuration nature, as a result which represents various functional setbacks ranging from packet drop because of dynamic change of configuration, transmission error, limited bandwidth, energy-constraint (limited capacity and short battery life), to restricted physical security which supports as the natural features of MANET [8]. Traditional network environment protocols (RIP, OSPF, EIGRP and IGRP) are unable to keep these challenging scenarios thus the requirement for suiting option. To this end, various routing protocols have been suggested and examined for MANETs. These protocols have been majorly categorized into three types of routing protocols; the Proactive, the Reactive and the Hybrid Routing Protocols [9].

2.1. Routing in MANET

One of the important challenges in MANET is growing support for routing [19] due to the combination of various features in the network i.e. rapid change of configuration, deficiency of infrastructure in place to help the movement and the communication of the nodes in the network.

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Routing in MANET can be categorized into two different classes, i.e. Unicasting and Multicast routing [22]. Both cover some kind of broadcasting mechanisms to send a packet from source node to destination node. Broadcasting which is known as Flooding [23] is a method or process of sending data from one node to another node in a interaction environment. It utilizes MAC protocol layer as a broadcast technique to transport packet from a source to the neighboring nodes. While Unicast routing is the method of holding a single path in a network among all pairs of nodes irrespective of whether all paths are actually utilized; Multicast routing means a single source node with various destination nodes to send a packet in a network environment [25]. Unicast routing method is very important because it hold a shortest route to destination node.

2.1.1 TORA Routing Protocol And Benefits

TORA is a reactive routing protocol and on which our study is concentrated. It is clear that nodes in MANET are self-organized; and do not need any management concern for nodes in the network to obtain and send information. inversely, communication only comes successful when each node behaves as a router on its own [26]. TORA is a reactive routing protocol which relates to link-reversal algorithm class, which because of its efficiency, scalability and adaptability is viewed adoptable in dense, large mobile networks [9]. TORA is observed to show the following abilities; (i) it demonstrates routes frequently (ii) it performs in distributive mode (iii) it offers loop-free route (iv) it offers multiple paths and (v) reduced communication overhead by setting algorithmic reactive to configuration changes when possible [9]. It exhibits some benefits over other reactive routing protocols i.e. adaptability, bandwidth efficiency and rapid route repair during connection failure, and offering various paths to destination nodes in wireless networks [27]. TORA restricts control message routing in highly dynamic mobile environment which is the primary aim behind the demonstration of the routing protocol, and it is a destination oriented protocol that provides support to both proactive and reactive routing [13]. It is planned to work towards high reactivity instead of routing optimality only in a high dynamic mobile surrounding due to its flexibility and that is its primary and secondary process that replaces other on-demand protocols [27].

2.2 VoIP and Its Characteristics in MANET

The growth of Voice over Internet Protocol (VoIP) cause to less cost telephony services. However it is one of the important applications that led to some issues in the network performance, exactly, due to the mobility of the nodes [28]. VoIP implementation on MANET framework is very easy [29] and the challenges can be solved with the utilization of strong routing protocols. However, attempts have been performed to enhance the MANET performance before they can be utilized for VoIP. VoIP is a practical scenario that can be studied to validate the MANET performance utilizing various routing protocols in a simulation environment, because it offers different support for modeling Transmission Control Protocol (TCP), Constant Bit Rate (CBR), ad-hoc routing, and multicast protocols over wireless and wired networks. Performance measurement of any MANET routing protocol that transports voice traffic based on the kind of coders utilized in the communication environment, and the factors to be taken are algorithm delay, complexity, and bit rate quality [30]. Also, the effect of any matrix on voice communication quality based on the codec employed [31].

III. System Modeling

The simulation system composed of five (5) components combined together to build a working system. These involve; Ad hoc nodes/nodes, a VoIP server, Ad hoc Network, a VoIP profile/Application and the VoIP Mobility model. The simulation system is integrated to duplicate the form of a real life MANET environment.

The process flow for TORA reactive routing protocol is in three phases. These involve; route establishment, route maintenance and route erasure. When call is started, it will be dropped, obtained or re-routed. It would be dropped depending on two conditions; either no legal path (if the nodes are in sleep mode or hidden because of less energy to participate) or when there is a connection failure in communication. However, if a call is obtained, then performance can be measured or there would be a trend of re-routing.

3.1 System Setup

the default setup contains of a simulation area of 500x500 meters with one hundred (100) nodes distributed at random and in random motion. The default encoding strategy for the simulation is G.711 codec with a packet size of 200 bytes positioned on every node in the network for transmission randomly. The starting time of the transmission is adjusted 0.0sec with constant mobility of 10m/s. This study considers a restricted examine parameters; codec type, mobility, MAC protocol and node density. This restricted selection is effected by time constraints against the long time that would be needed in performing a thoroughly performance on whole parameters. The metrics for evaluation are jitter, end-to-end delay, Mean Opinion Score (MOS) and throughput. All of these characteristics are essential to evaluate the TORA-routing protocol performance in a mobile Ad Hoc voice communication network

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IV. Analysis of Results

Given the OPNET simulator explained earlier, and having carried out the simulation factors seen into during the test involved; node density, mobility, MAC protocol and encoding strategies and for which test metrics of jitter, end-to-end delay, Mean Opinion Score (MOS) and throughput were performed. Below are the results received and their evaluation.

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4.1 Jitter Analysis

The jitter of voice communication in the MANET utilizing TORA routing protocol is less than 0.1sec as communication time increased and it arrived its highest level between 75 to 85 seconds. This means continuous communication. MAC layer protocol also has no effect on voice jitter.

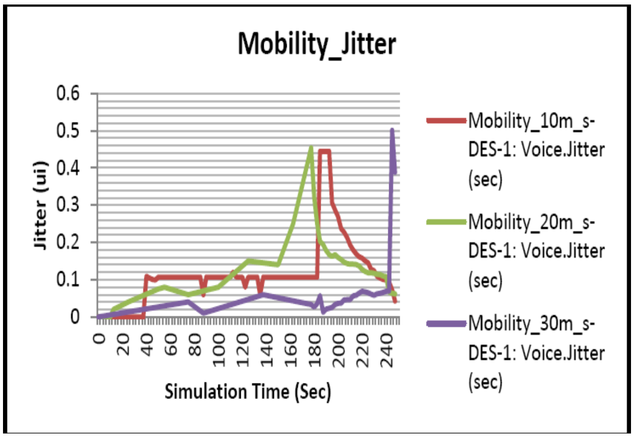

Figure 1: Mobility Jitter

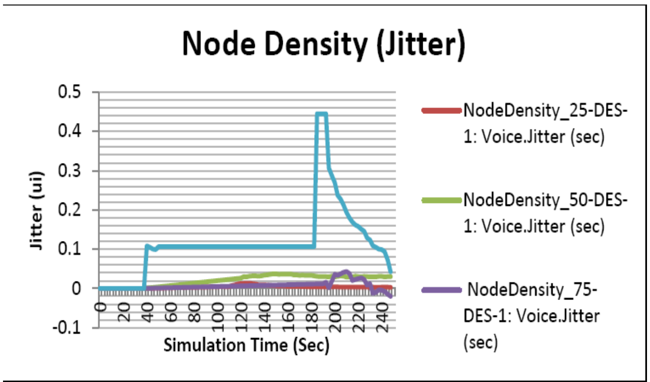

Figure 2: Node Density Jitter

4.2 End-to-end Delay Analysis

It is realized that end-to-end delay of a network with node density parameters begins at about 40 seconds and increases to about 96 seconds with a less time of communication. This remained constant even with the change in MAC layer protocols and (or) variations in encoding strategy.

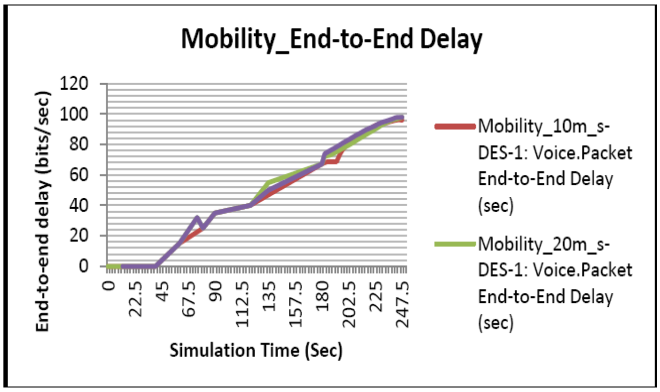

Figure 3: Mobility End-to-End Delay

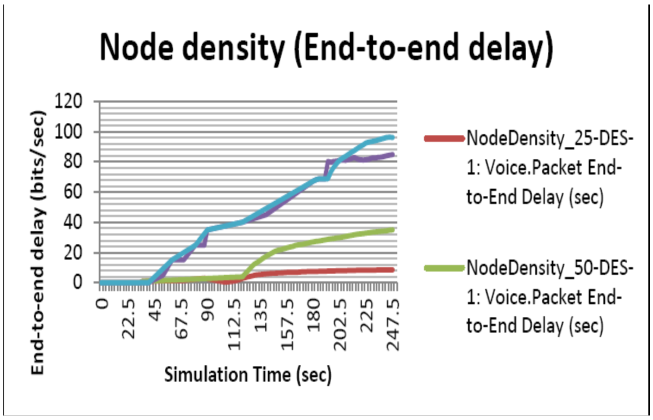

Figure 4: Node Density End-to-End Delay

4.3 Mean Opinion Score (MOS) Analysis

Mean Opinion Score (MOS) factor keeps a stable value of 1 from 70 seconds. This value is duplicated in the MOS values received while measuring the performance of the network with ranging encoding strategies,

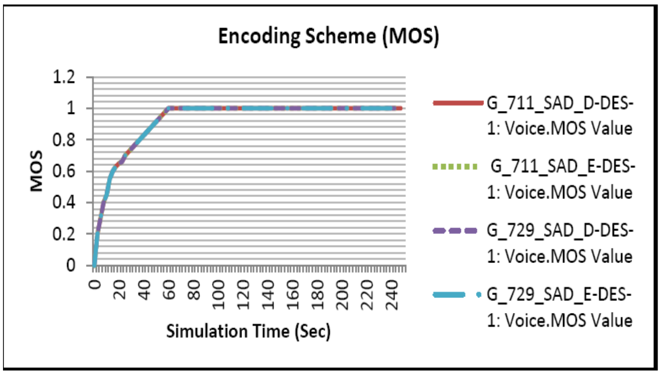

Figure 5: Encoding Scheme MOS

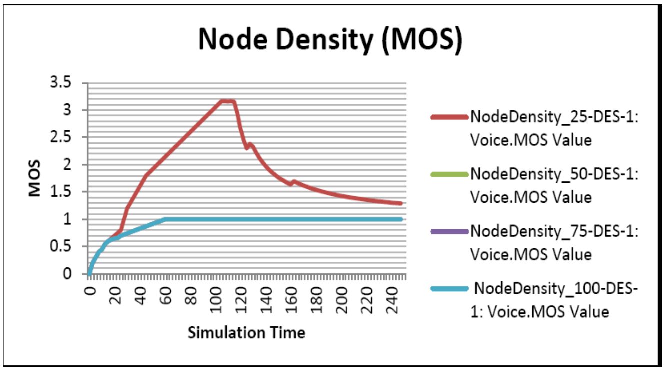

Figure 6: Node Density MOS

4.4 Throughput Analysis

From the default setup, network throughput increases to a highest of 0.6 bit/sec more than midway the transmission time. However, a extreme drop is also observed with increasing in the time of transmission. Change in encoding strategy does not influence this nature in any way, and the encryption characteristic do not form the situation any better. Changes in

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the MAC layer protocols also do not change the behaviour. A highest throughput of 0.6bits/sec is still kept all the way.

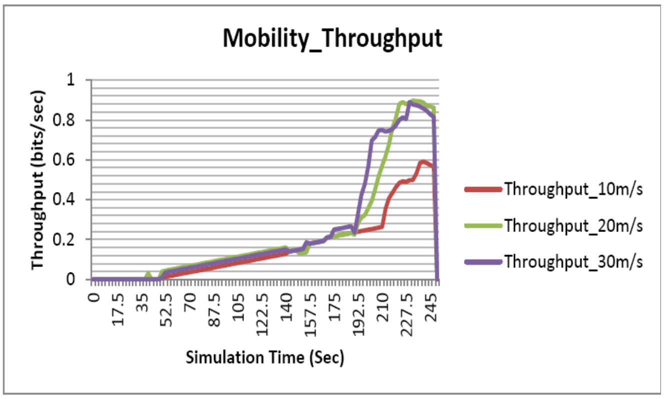

Figure 7: Mobility Throughput

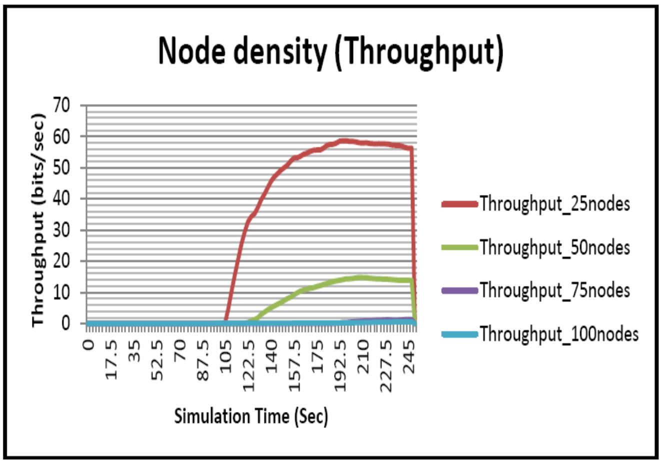

Figure 8: Node Density Throughput

V. Conclusion and Future Work

The Node Density and Mobility are main factors that change the behaviour of TORA-enabled Mobile Ad hoc Network. TORA has three phases of operations (route establishment, route maintenance and deletion); the time considered for route reply is not defined in the route creation phase. Jitter is viewed to be badly influenced by the mobility of the nodes. Furthermore, the results also show that an increase in speed of the nodes on the network effect a resultant increase in bit rate error. Node density also led strict effect on network end-to-end delay. A maximum number of nodes are viewed to make worst the delay i.e. packets cannot be transmitted effectively. However, as the nodes number decreases, the delay goes toward reduction, permitting for effective communication between nodes. Although normal voice quality is not very recommending, less number of the nodes within the network build better results an average of 3.2 MOS value is received which is assumed fair. This means that communication in an ad hoc network utilizing TORA is more effective and productive with less number of nodes. It could also be observed that given the usage of TORA routing protocol in MANET, quality of voice communication is not proportionate to node density. Increase in the number of nodes highly degrades voice quality. Total throughput is also effected by the density of nodes and mobility.

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