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Impact of Beacon Period on the QoS metrics of Temporally Ordered Routing Algorithm in Mobile ADHOC Networks

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ABSTRACT
Mobile Adhoc Networks [MANETs] involve communication between different mobiles nodes which themselves act as routers and help in transmitting data packets to the destination through intermediate nodes which lie within the radio transmission range of each other. Due to the high level of dynamism, reliable, rapid and energy efficient routing of data packets from the source to the destination is an area of great interest for researchers. In this paper, we show the impact of the default beacon period and modified Beacon Period of various networks on QoS metrics of TORA using OPNET Simulator 14.5.
Keywords :- MANETs, TORA, Beacon Period.

I. INTRODUCTION

MANET [1] [2] is a collection of wireless nodes that create a dynamic wireless network among them without any infrastructure. Ad-hoc is a communication mode that allows nodes to directly communication with each other without a router. In Latin, ad-hoc means "for that special purpose". In ad hoc networks, nodes do not start out common with the topology of their networks; instead, they have to discover it. The basic idea is that a new node may announce its presence and should listen for announcements broadcast by its neighbors. Each node learns about nodes nearby and how to reach them and may announce that it, too, can reach them. An ad-hoc network can be sub-divided into two classes. In Static ad-hoc network the positions of a node may not change once it has become part of the network. In the mobile ad hoc network, nodes can directly communicate with all the other nodes within their radio ranges; whereas nodes that not in the direct communication range use intermediate node(s) to communicate with each other. In these two situations, all the nodes that have participated in the communication the direct communication range use intermediate node(s) to communicate with each other. In these two situations, all the nodes that have participated in the communication automatically form a wireless network, therefore this kind of wireless network can be viewed as mobile ad hoc network. A Mobile Ad hoc Network (MANET) is a system of wireless mobile nodes that dynamically self-organize in arbitrary and temporary network topology.

II. ROUTING PROTOCOL

A Mobile Ad hoc Network (MANET) is a wireless mobile node that dynamically self-organizes in random and temporary network topologies. People and vehicles will be internetworked in areas while not a pre-existing communication infrastructure or once the utilization of that type of infrastructure needs a wireless extension. In the mobile ad hoc network, nodes can communicate directly with all the other nodes within their radio ranges; whereas nodes that not in the direct communication range use neighboring nodes to communicate with each other.

The need for mobility in wireless networks caused the creation of the MANET working group within The Internet Engineering Task Force (IETF) for developing steady IP routing protocols for both static and dynamic topologies. In a MANET, mobile nodes have the capacity to accept and route traffic from their neighbors towards the destination, i.e., they act as routers as well as hosts. As the network grows, and coupled with node mobility, the challenges linked with self-configuration of the network become more obvious. More frequent connection disconnections and reconnecting place an energy constraint on the mobile nodes. Ad hoc routing protocols are refined with mechanisms to cope with the dynamic nature of MANETs.

TORA (TEMPORARY ORDERED ROUTING PROTOCOL)

TORA [3] is an on-demand routing protocol that is highly adjustable, skillful, scalable and distributed routing algorithm. It is based on the notion of Link Reversal and recommended for highly dynamic mobile and multi-hop wireless networks. Link reversal algorithms provide a simple structure for routing in MANETs [4][5][6][7][8] and maintain routes to a particular destination node even during frequent updating in the logical structure of the network. These are adaptive, self-stabilizing, distributed mobile ad hoc routing algorithms which form the basis of TORA routing algorithm. TORA [9] finds out several routes from a source to a destination node. Each node maintains routing information about adjacent nodes. During any topological change, the control messages are exchanged among the set of nodes which are located near the region of occurrence of that topological updating. This has been marked as an important and main feature of TORA protocol. It basically involves three tasks:

- Route Creation
- Route Maintenance
- Route Erasure

1. Route Creation by TORA

It is done by using two packets:- QRY (Query) and UPD (Update) packets.

Step 1: Set the height and the reference level of the destination node to 0 and that of all other nodes to NULL (Not defined).

Step 2: Source will broadcast the QRY packet having destination node ID in it.

Step 3: A node whose height is not NULL will respond with UPD packet which contains the height of that particular node in it.

Step 4: Every node that receives this UPD packet will set its height to one more than that included in the UPD (i.e. one more than the height generated by the node which created the UPD packet). A DAG (Directed Acyclic Graph) is formed and arrows indicate the direction in which the UPD packet is received.

2. Route Maintenance by TORA

A node with higher height is said to be on upstream link whereas a node with lower height is said to be on downstream link. For example; nodes 6 and 7 are on upstream links for node 8 and node 8 is on the downstream link for these nodes. Whenever a node moves from its location, the route of the DAG is wrecked and route maintenance phase is called to reestablish the DAG for same destination node again. When the last downstream link of a node fails, it leads to a new reference level. This new reference level is propagated to the neighboring nodes and links are then inverted to reflect the changes made while adjusting to the new reference level. Here node 7 changes its location, hence node 5 forms a new reference level 1 because its downstream link to node 7 has failed i.e. there is now no outgoing link from node 5. The links towards nodes 2 and 3 are now reversed. So in TORA link reversal occurs only when there is no outgoing link.

3. Route Erasure by TORA

TORA floods the network with a broadcast clear packet CLR to initiate the route erasure phase thereby erasing all the invalid routes. Whenever there is a partition in the network, the CLR packet is sent by the node which detects the partition. When a CLR packet is received by a node, it resets the hierarchy of all neighbor nodes to NULL and the route creation process is started again from the last node which receives the CLR packet. The partition is detected by nodes 5 and 6. Hence these nodes broadcast a CLR packet to initiate route erasure.

Advantages: TORA supports multiple routes. It maintains multiple route possibilities for a single source/destination pair. Bandwidth is maintained because of the fever route build up. TORA also supports multicasts

Disadvantages: TORA'S reliance on synchronized clocks limit in applicability. If the external time source fails, the algorithm ceases to operate. Also, route re-build may not occur as quickly due to oscillations. During this course this can lead to lengthy delays while for the new routes to be set.

INTERNET MANET ENCAPSULATION PROTOCOL

TORA [10][11][12] is layered on Internet MANET Encapsulation Protocol (IMEP). This is to ensure notifications about link status and reliability in the delivery of control messages. IMEP is a protocol designed to support the operation of many ad-hoc routing protocols. The idea is to have a common general protocol that all routing protocols can make use of it. It incorporates identification, addressing, identification and interface. IMEPs main purpose is to enhance overall performance by minimizing the number of control messages and to put common functionality into account. IMEP provides architecture for MANET router. IMEP provides services that TORA depends on upon such as link/connection status sensing, broadcast reliability, and message aggregation. In connection to the Open Systems Interconnection (OSI) Model, IMEP sits below TORA with both protocols residing at the network layer. In turn, IMEP uses the benefits provided by the Institute of Electrical and Electronics Engineers (IEEE) 802.11 Medium Access Control (MAC) protocol, a data link layer protocol. The above description of IMEP is based on the internet draft of IMEP developed by Corson et al.

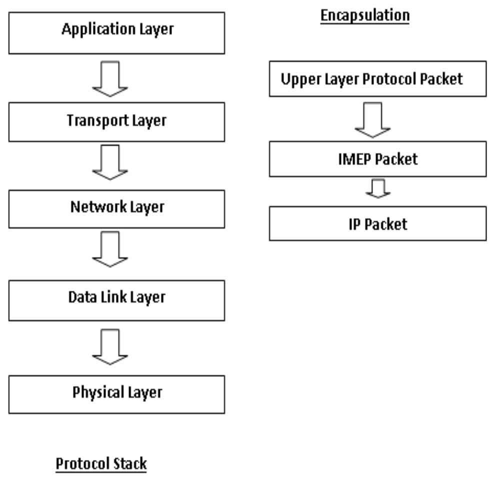

Figure 1: Internet MANET Encapsulation Protocol

A. Message Aggregation

Message aggregation encapsulates IMEP's owned routing control packets and packets passed down by TORA into a single object block message (OBM). This reduces the number of channel accesses needed since a single OBM packet is sent instead of smaller, multiple IMEP and TORA packets.

B. Link/Connection Status Sensing

Link/connection status sensing provides TORA with exact and current link status information of a node to its neighbors and whether the links are unidirectional or bi-directional. It operates using the explicit and implicit method of link failures detection.

1) Explicit Link Failure Detection Method: This method regulates link status information by having a node i broadcast BEACON packets to its one-hop neighbors. When node i receives a reply in the form of an ECHO packet from a neighbor, it labels the link to that neighbor as bi-directional. Node i continue to send BEACON packets at every BEACON PERIOD interval and fix a MAX BEACON TIME, defined from the maximum number of BEACON retransmissions multiplied by the BEACON PERIOD. If node i does not get any ECHO packet after MAX BEACON TIME, it designs that link as down and notifies TORA.

2) Implicit Link Failure Detection Method:
This method uses the OBM packets that IMEP sends, where nodes who receive an OBM packet reply with a packet of ACK. This procedure reflects that of the BEACON and ECHO packets used in the explicit method explained earlier. Similarly, there is a MAX RETRANS TIME formed up of the RETRANS PERIOD between each retransmission multiplied by the most number of retransmissions. After MAX RETRANS TIME, any neighbor that did not reply with an ACK packet has its link labeled as down and TORA will be notified.

C. Broadcast Reliability

Broadcast reliability can be any mix of two transmission modes of broadcast or multicast, and also two reliability modes of unreliable or reliable. Specifically, TORA requires broadcast reliability in the reliable and broadcast mode, ensuring in sequence transmission of messages and broadcasting to all of its neighboring nodes. The broadcast mode requires all neighboring nodes to acknowledge any OBM packet sent and this facilitates link/connection status sensing in the implicit method of link failure detection.

III. METHODOLOGY

This is to evaluate the performance of existing wireless routing protocol TORA with default beacon period and with modified beacon period. The simulations have been performed using OPNET version 14.5 a software that provides scalable simulations of Wireless Networks. For this, the simulation is carried out within a 500m X 500m area by increasing the number of nodes, placed in Random Deployment Model and Random way point Mobility model. In this scenario, we differentiated Beacon Period into two categories. One is default Beacon Period valued 20, another one is modified Beacon Period valued 16. We have simulated three scenarios: 30 Nodes as low network (Figure 2), 60 Nodes as medium Network (Figure 3) and 90 Nodes as large networks (Figure 4). Now we simulated Default Beacon Period and Modified Beacon Period to the low, medium and large networks.

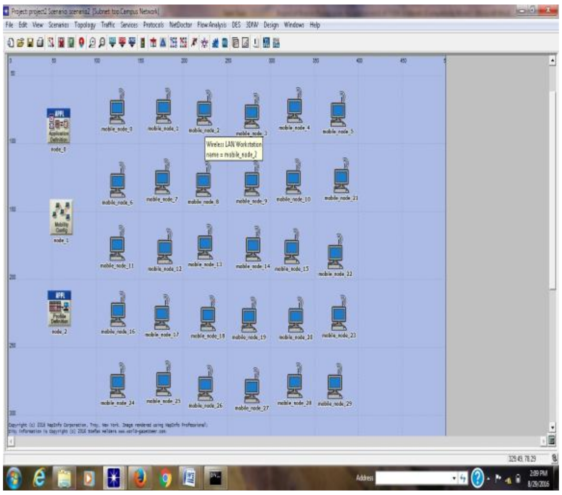

Figure 2: Scenario for 30 Nodes

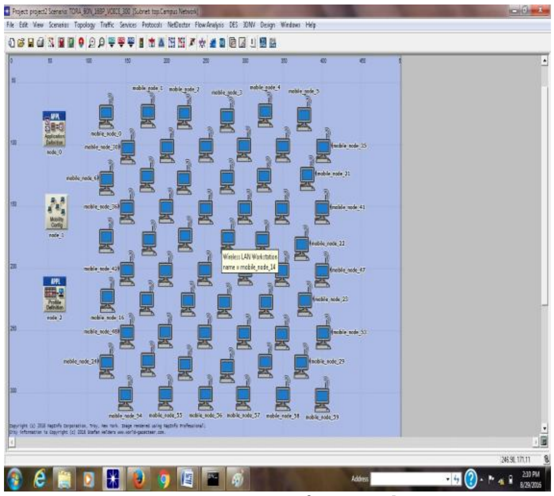

Figure 3: Scenario for 60 Nodes

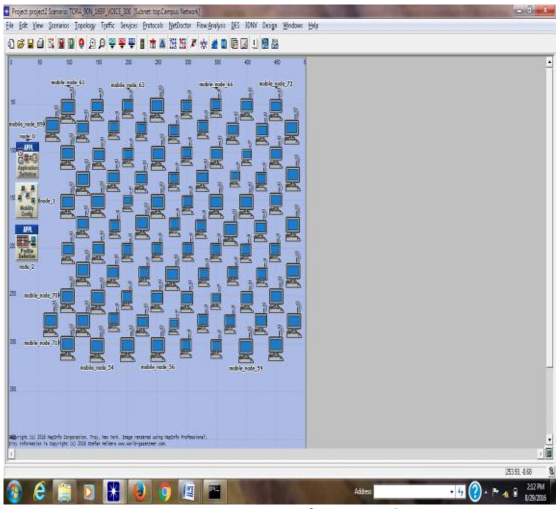

Figure 4: Scenario for 90 Nodes

IV. SIMULATION ENVIRONMENT

Parameters	Values
Area	500m x 500m
Nodes	30, 60, 90
Nodes placement	Random
Mobility Model	Random Way Point
Beacon Period	20,16
Node Transmission Power	0.005
Operational mode	802.11b
Data rate	11Mbps
Simulation time	300sec
Defacto values set	MANET
Routing protocol	TORA

Table 1: Wireless Network Deployment model

V. RESULT AND DISCUSSION

To evaluate the performance of routing protocols, the following metrics are considered:

Throughput (bits/sec): Represents the total number of bits (in bits/sec) forwarded from wireless LAN layers to higher layers in all WLAN nodes of the network. Throughput is high for small and large network for modified Beacon Period. Default Beacon Period is good in Medium network as seen in Figure 5.

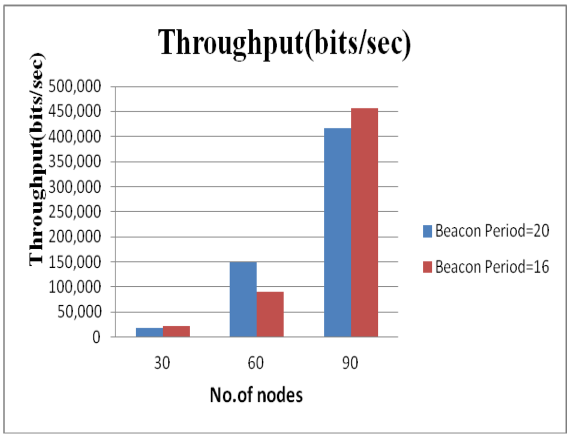

Figure 5: Variation of throughput with simulation time

Delay (sec): Represents the end to end delay of all the packets received by the wireless LAN MACs of all WLAN nodes in the network and forwarded to the higher layer. Delay is low for medium network and high for small and large network for modified Beacon Period as seen in Figure 6.

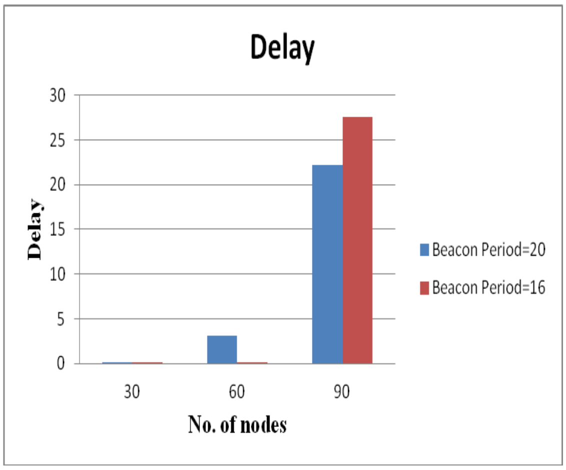

Figure 6: Variation of delay with simulation time

Load (bits/sec): Represents the total load (in bits/sec) submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network. Load is high for small and large network for modified Beacon Period. Default Beacon Period is good in Medium network as seen in Figure 7.

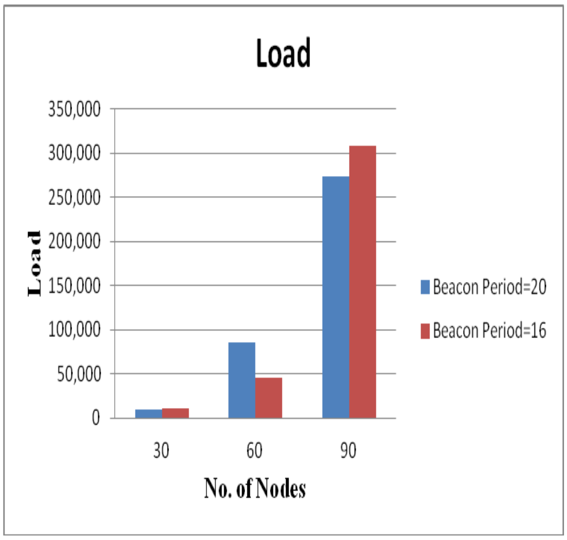

Figure 7: Variation of load with simulation time

VI. CONCLUSION

In this paper, we have analyzed performance evaluation of QoS metrics for TORA routing protocol in MANETs by varying number of nodes with default Beacon Period and modified Beacon Period. From the simulation results we observed that the modified Beacon Period is better in small and large networks and less in medium network. The default Beacon Period is good in only medium network.

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