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Effect OF Increasing Number OF Nodes on Performance OF GRP Routing Protocol for Circular Node Placement Model with Various Traffic Loads Over Mobile Ad Hoc Networks Using OPNET 14.5

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ABSTRACT
Due to the increased use of mobile devices with the high demand for applications , most companies have tended to pay attention to Mobile Ad hoc Networks . This type of network is characterized by multi-hop wireless networks where data packets are sent in a "store and forward" manner from source to an arbitrary destination via intermediate nodes. The mobile nodes are connected by multi-routes routing as the nodes in this network not only serve as hosts but also as routers where data is routed to and from other nodes in the network and therefore the mobile node not only sends its data packets but also sends data packets of other mobile nodes . The network architecture changes dynamically, mainly because of mobility of nodes , so we need routing protocols to establish the connection. Routing protocols are categorized into proactive routing protocols , reactive routing protocols and hybrid routing protocols .

So, in this paper, we has been studied effect increasing number of nodes on performance GRP routing protocol which is one of hybrid routing protocols for various traffic loads with using circular node placement model on the basis of Wireless LAN and GRP Statistics and evaluated performance in a large network and in a small network.

Keywords: Mobile Ad hoc Networks, routing protocol, various Traffic loads, GRP, Circular Node Placement Model.

1. INTRODUCTION

1.1 ROUTING PROTOCOLS:

Mobile Ad Hoc networks are characterized as networks with multi-hop topology that change continuously due to mobility, and therefore in this type of network we need efficient routing protocols capable of establishing communication routes between nodes without causing control messages load or computational surplus on mobile devices with limited power. [1][2][14][17][23].

Several solutions have been proposed, some related to calibration within Internet Engineering Task Force (IETF) and others try to have the most recent route for all other nodes at all times by exchanging control information periodically when topology changes occur.These protocols are called proactive routing protocols , which are modified versions of traditional connectivity or distance vector protocols taken in wired networks that adapt to specific requirements of dynamic mobile ad hoc network environment. [2][14][17][23].

Others do not have to have the most recent route to all other nodes, and therefore we have reactive protocols that discover the routes on demand by means of route discovery procedure and these routes remain in an active state as long as they are used and there is another type of protocol that merges the previous two types called hybrid protocols [2][14][17][23] The following figure (1) shows the structure of mobile ad hoc networks [3].

Figure (1) structure of mobile ad hoc networks .

1.2. RESEARCH PROBLEM AND OBJECTIVES:

Mobile ad hoc networks constitute a group of mobile nodes that share the wireless channel without any central administration [1][3][4][23]. The nodes in these networks function not only as hosts but rather as routers at the same time as the nodes in this type of network are able to move and thus the network topology changes frequently and this means that the communication between the nodes is difficult to manage. [1][3][4].

A distinction is made between three types of routing algorithms, which are: the first type is proactive protocols that exchange routing information between nodes continuously, the second type is reactive protocols in which the route is built on demand, while the third type is hybrid protocols in which the previous two types are combined, including (GRP) geographical routing protocol to be studied [3][4] [15][23].

In this article, we study effect increasing number of nodes on performance of GRP (Geographical routing Protocol) routing protocol, which is considered one of hybrid routing protocols with different traffic loads (Database, Email, FTP, HTTP, Video Conferencing, Voice) in case circular node placement model in terms of wireless local area network (WLAN) standards and GRP routing protocol standards, which are found in the simulator statistics, in a large network consists of 60 mobile nodes and in a small network consists of 30 mobile nodes and we can briefly summarize a definition of some performance metrics used in the simulation process.

- ✓ Throughput: represents the amount of digital data sent per unit time from source node to destination node. It is measured by *bits/sec* [5] [7][11] [12][18][20][21].
- ✓ Load: The total load is expressed in bits / second, as all upper layers send it to all layers of wireless network in wireless nodes of network [5] [7][12][20].
- ✓ Delay: represents the average time taken for packets to reach from source node to destination node [5][7][11][12][18] [21] [20][23].

1.3. STUDY METHODOLOGY AND TOOLS :

OPNET 14.5 network simulator was used as it was installed on Windows 7, and 12 system variables were created and modified, and the process of installing this simulator was made sure of success [9].

Then, in this article, scenarios were implemented that aim to study effect increasing number of nodes on performance of geographical routing protocol with different traffic loads (Database, Email, FTP, HTTP, Video Conferencing, Voice) in case circular node placement model in terms of wireless local network. (WLAN) standards and GRP routing protocol standards and found in the simulator statistics, in a large network consists of 60 mobile nodes where network size was 1000x1000m and in a small network consists of 30 mobile nodes where network size was also 1000x1000m.Firstly, performance of geographical routing protocol was evaluated in case circular node placement model with database application in a small network consists of 30 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards ,also evaluated performance of geographical routing protocol in case circular node placement model with a video application in a small network consists of 30 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.performance of geographical routing protocol was also evaluated in case circular node placement model with email application in a small network consists of 30 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.In addition, performance of geographical routing protocol was evaluated in case circular node placement model with a FTP application in a small network consists of 30 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.Then, performance of geographical routing protocol was evaluated in case circular node placement model with HTTP application in a small network consists of 30 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards . In addition, performance of geographical routing protocol was evaluated in case circular node placement model with a voice application in a small network consists of 30 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.Secondly, performance of geographical routing protocol was evaluated in case circular node placement model with database application in a large network consists of 60 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.performance of geographical routing protocol was also evaluated in case circular node placement model with video application in a large network consists of 60 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.performance of geographical routing protocol was also evaluated in case circular node placement model with email application in a large network consists of 60 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.In addition, performance of geographical routing protocol in case circular node placement model was evaluated with FTP application in a large network consists of 60 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.Then performance of geographical routing protocol was evaluated in case circular node placement model with HTTP application in a large network consists of 60 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.In addition, performance of geographical routing protocol in case circular node placement model was evaluated with voice application in a large network consists of 60 mobile nodes in terms of wireless local area network (WLAN) standards and GRP routing protocol standards.As for the last and most important part of the article, effect increasing number of nodes on performance of geographical routing protocol was studied and compared in a small network consists of 30 mobile nodes in case circular node placement model and between its performance in a large network consists of 60 mobile nodes in case circular node placement model in terms of wireless local area network (WLAN) standards and GRP routing protocol standards, which were found in the simulator statistics for different traffic loads (Database, Email, FTP, HTTP, Video Conferencing, Voice) where network size was whether network was large (number of nodes was large) or small was 1000x1000m.The results in tables were obtained through the excel files of each chart obtained as a result of implementing Simulation over a time of 600 seconds by clicking on the chart with the right button and selecting (Export Graph Data to Spreadsheet), then moving to an excel file containing digital data for the chart, and then the factor we want was calculated, for example: Average.

1.4. CLASSES OF ROUTING PROTOCOLS:

The routing protocols of mobile ad hoc networks can be classified into three sections:

✓ **Proactive protocol:**

In this type, nodes in mobile ad hoc network keep routes entries to all possible destinations and this is important because when a node wants to send a data packet, route is predefined, and thus it can be used directly. And when there is a change in network topology, this change is being deployed it to the entire network and on the basis of the gathered information, each wireless node changes its routing table, for example, when a change in topology makes the original route unavailable, then any new route is established, and therefore all nodes will receive updates on the state of the route and in the absence of a change in network topology, node is ready and available on demand [3][23]. Distance vector protocols can also be considered proactive protocols [19]. Hence, proactive view is similar to UDP (non-established communication) communication and hence the presence of transport protocols is preferred in proactive routing protocols[10] . We mention Enhanced Link State Routing Protocol [2][3][11][15].

✓ **Reactive protocol:**

Where source node builds routes on demand, and thus network topology is discovered on demand, that is, when a wireless node needs to send data to another wireless node, but there is no route to that node, then source node will call route discovery process as it begins to prepare to send routing table and when a route is found and maintained by routes maintenance procedure until the destination is no longer accessible or the route is no longer used[8][11][13] [15] [23] [24] .The route is deleted by route delete procedure [24]. The nodes only maintain routes to effective destinations [13]. Hence reactive view is similar to TCP (establish connection) communication [10]. We mention dynamic source routing protocol(DSR) [3][11][24] .Table (1) shows a comparison between reactive protocols and proactive protocols [3]:

Table 1: Reactive and Proactive protocols

	Proactive protocols	Protocols Reactive
Routing Protocols	DSDV,CGSR,WRP,OLSR	AODV,DSR,TORA,ABR,SSR,CEDAR
Route acquisition delay	Low	High
Load resulting from control messages	High	Low
Energy requirements	High	Low
Package bandwidth requirement	High	Low

✓ **Hybrid Protocols:**

- This type of protocol combines advantages of Proactive Routing Protocol (PRP) and Reactive Routing Protocol (RRP) [7]. PRP is suitable for supporting delay-sensitive data such as audio and video, but it consumes a large portion of network capacity while RRP is not suitable for real-time communication, but positive with this view is that it can dramatically reduce routing load when network is static and data is light but on in any case, source node must wait until the route to destination is discovered, and this increases response time [7][20].
- Hybrid routing performs in two ways : greedy routing , face-2 algorithm or perimeter routing[16] . Using concept of location-based routing, geographical routing protocols do not need to be set up or maintain connections [16]. In hybrid routing, nodes are not required to store routing tables, nor do they keep up-to-date routing tables for purpose of sending information as they simply discover destination node's location in network and simply send information from starting place to destination as method of sending information in these protocols is based on Location information for destination node and existing neighbors after one hop[16] . In hybrid routing there are two types of transmission strategies: Greedy forwarding, Face-2 Routing or Perimeter [16]. Figure (2) shows types of hybrid routing [16].
- For Greedy forwarding , the sender knows location of receiver node by GPS and message is then passed to the neighbor closest to receiver node [16][20] . As for intermediate nodes, they send data to a two-faced neighbor on their way to receiver node and this process continues until data reaches receiver node [16][20]. Each node in network maintains its own table in which location of each node is listed [16]. The main difficulty in greedy forwarding is to choose the exact neighbor node into which data will be sent[16][20]. The various routing strategies consider scalability, space and orientation towards receiver node [16]. There are three different routing strategies in greedy routing for choosing which of neighboring nodes to which data packets should be sent are Most Forwarded within R (MFR), Nearest with Forwarded Progress (NFP), Compass Routing [16]. Figure (3) shows Greedy routing strategies [16]. we notice from Figure (3) that there are different strategies for how sender sends information from source to destination , where S refers to source node and D refers to destination node [16]. The area around with r denotes coverage area or the maximum field of S [16].
-The main goal is to send information from S to that node closest to destination . In the given example, this node could be C, which could be closest to destination node within coverage area of destination node D, and this strategy is known as Most Forwarded within R (MFR) and this strategy tries to reduce number of hops for

sending information from S to D [16] . MFR is the most commonly used in those scenarios where data packet does not change or Adjust the signal strength for communication between S and D [16]. However, in any scenario in which data package adapts or modifies its signal strength, a different strategy is used, which is Nearest with Forwarded Progress (NFP), as in NFP the message is passed to the nearest neighbor of sender who is closest to destination . In the given example the node is A[16] .If all nodes use NFP strategy, the collision of data packets can be greatly reduced during transmission[16] .

- Another strategy used in greedy forwarding is compass routing, where you choose sender node closest in the straight line between source and destination . In the given figure, the compass routing node is B node [16]. This routing strategy is used to reduce distance as data packet travels from source to destination [16] .When data packet arrives at a node that has not yet detected any of neighboring nodes close to destination in a forwarding routing method, the second method of hybrid routing is Face-2 routing or Perimeter Routing used to determine destination address [16]. Figure 4 shows Greedy Routing Failure [16] . we find from Figure (4) the semicircle around D has a radius of distance between S and D, and the circle around S shows the S field [16]. We notice from Figure (4) that there is no direct communication between S and D and therefore greedy forwarding fails in this case. To avoid the restrictions of greedy forwarding methods, there is another method used known as Perimeter Method or Face-2 Algorithm [16]. The face-2 algorithm is based on planner graph traversal, where the node does not need to store any missing or additional information, as greedy forwarding mode is continued when the node reaches the nearest node and then to destination [16] . Figure (5) shows planner graph traversal. Planner graphs can be defined as diagrams without intersecting perimeters, as nodes are peaks and the edge is between two peaks in case they are the closest to direct contact with each other [16]. In a planner graph traversal, data packet is sent along the route by using the right-hand rule, where data packet is directed to the next hop counterclockwise from the edge it reached [16]. The drawn line in Figure (5) between source node S and destinaton node D intersects more than one edge, so these edges are not chosen for sending data [16] .

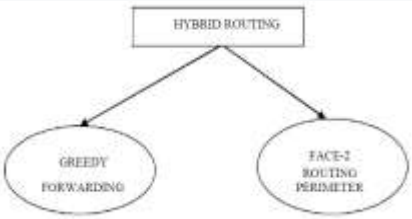


Figure (2) types of hybrid routing

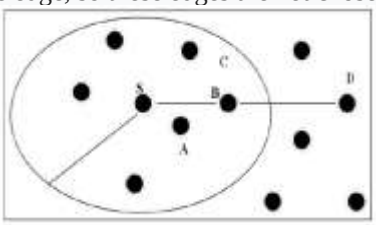


Figure (3) Greedy routing strategies

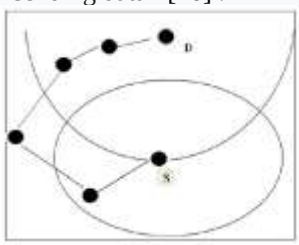


Figure (4) Greedy Routing Failure

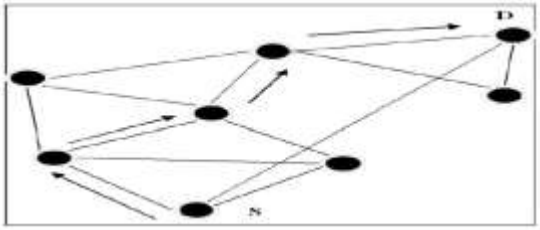


Figure (5) Planner Graph Traversal

1.5. HYBRID PROTOCOLS:

1.5.1 GRP (Geographical Routing Protocol or Gathering-based Routing Protocol) :

The function of gathering -based routing protocol in mobile ad hoc networks is to rapidly collect network information in source node without a large amount of loads by taking advantage of strengths of proactive routing protocol and reactive routing protocol, and thus data packets are sent continuously even if the route is interrupted with little transmission delay without compromising load or control performance[7] . That is, geographical routing protocols are more efficient when there is a dynamic change in network topology, high mobility and scalability, and thus geographical routing is used to remove restrictions related to topology-based routing as data packets are sent to their destination taking into account their location [16].

- Geographical-routing protocol is a location-based routing protocol that is classified as a distance-based and proactive routing protocol as it is based on Greedy algorithm where each node must maintain a table and this algorithm assumes that each node in network knows its own location through *GPS* [5][12][15][16][20][25]. That is, routing is based on the shorter geographical distance between source node and destination node [12] [25]. The location of node is determined by GPS and network flooding will be improved by dividing the network into quadrants [5] [12] [15].Where network flooding process occurs when the node travels a longer distance than distance specified by the user or when the node crosses a quarter of a circle, and thus once the initial flooding process in network is completed, each node becomes aware of the initial location of all other

nodes that can be accessed [5][15][25 .Thus, geographical-routing protocol sends data packets to destination that is determined according to the shortest route that was calculated by source node according to the aggregated information contained in network information collection (NIG) packets that are broadcasted publicly by destination node [20][25] . Fortunately, each node maintains one or more routing tables to update the neighbors' nodes information, so each node with its location can determine which quadrant it settles in, and it can also know the initial location of all neighboring nodes [5][12] [25] . Likewise, each node broadcasts a public and periodically hello message to its neighbors so that locations of its neighbors are updated after the initial preparation, as the rate of welcome messages exchange depends on advantages of network, especially mobility of nodes [25] .

- Initially a hello protocol or hello message will be exchanged between nodes to determine neighbors and their locations[5][12][15]. The following figure (6) shows how to divide network into several quadrants to reduce network flooding with messages[5] [12][15][25]. The fully mobile ad hoc network is divided into quadrants and all quadrants of a circle are squares [5][12][15] . The quadrant size is specified by the user in meters[12]. From Latitude, Longitude (-90, -180) to Lat, Long (+90, +180) as Latitude, Longitude [12][15]. All four quadrants of a circle (square) form a higher level quadrant[12]. Aa1, Aa2, Aa3, Aa4 are individual quadrants in Level 1[12]. They form a quarter (Aa) in Level 2 and Aa, Ab, Ac, and Ad. are individual quadrants in Level 2 and they form a quarter (A) in Level 3[12]. Network flooding concepts in geographical routing protocol include knowing the initial location of each node and other nodes that can be accessed in network [12]. When the node crosses quadrant boundary, network flooding occurs again, but the extent of network flooding depends on distance traveled by node, taking into account quadrant boundary[12]. If node is only moving within its quadrant, then network flooding packets are sent only to nodes within quadrant [12]. If node is moving from quadrant Aa1 to Aa2 (within boundary of quadrant level 2), then all nodes within quadrant Aa are sent them network flooding process packets [12]. If node is moving from quadrant Aa2 to Ac1 (within boundary of quadrant level3) then all nodes within quadrant A are sending them network flooding packets [12]. When network flooding process packets are received outside intended boundary, these packets are discarded[12]. The number of network flooding attempts in geographical routing protocol is set to a value of 1 by default and can be set to a value of 3 as in the scenarios in my simulation. Therefore, number of times that flooding process occurs is few, and this requires that accessible nodes be discovered.
- The network flooding process with messages about location and flooding angle plays a basic and important role in tuning geographical routing protocol, where the initial value of flooding angle about location and dynamically network flooding with messages about location is changed in the intermediate nodes (increase value of flooding angle about location when intermediate node knows that there are no neighbors nodes within the request zone defined by flooding angle about location that were completed in the connecting route request [12]. The value of number of times during which network flooding process about location and the time intervals between them depends on movement of the nodes [12]. The nodes are only allowed to travel 5 meters in my simulated scenarios. Therefore, it is easy to find a node when its last location in GPS is known as search area for a node is limited[12]. The flooding angle is represented by an integer called request level which has the following meaning [12]:

Request_level = 1, flooding angle 90˚ 2, flooding angle 180˚ 3, flooding angle 360˚

- As for the backtracking technique used on the blocked routes in geographical routing protocol, as the nodes that receive the backtracking packet calculate the next closest neighbor to destination node and send it the new route [12][25]. if node that received the backtrack packet does not have an alternate route , then it in turn backtracks to a previous node to find an alternative route , at the end if it is no alternative route is available after all the recursive backtracks till source node, then data packet is dropped or discarded [12].

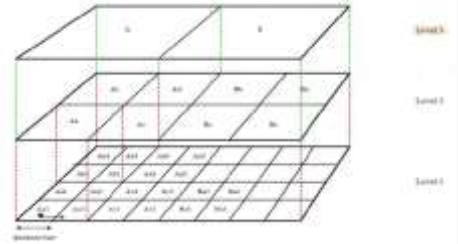


Figure (6) Dividing mobile ad hoc network into quadrants

1.6 NODE PLACEMENT MODELS :

Node placement or node positioning: It is method by which each node will be located in network in an efficient manner in which no large amount of energy is consumed while sending packets or data in network [6]. There are three ways to define where each node is in network or how nodes are arranged in network.

- **Random node placement model** :This model spreads nodes in a random manner, that is, nodes are distributed in network unequal and uneven, and thus coverage area is small if we have a large number of nodes that are far from each other unequal distances, and this leads to higher energy consumption and reduces life time of general network [6] [22] . Figure (7) shows random distribution of nodes within random nodes placement model[22].
- **Grid node placement model**:: This model spreads nodes in a grid manner, and thus coverage area is large if we have a small number of nodes that are far from each other equal distances [6][22]. Figure (8) shows equal distribution of nodes within grid node placement model[22] .
- **Circular node placement model:** This model spreads nodes in a circular manner, and thus coverage area is large if we have a small number of nodes that are far from each other equal distances [6].

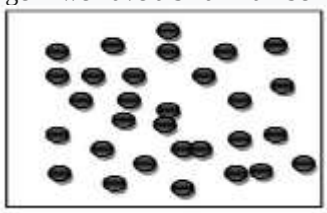


Figure (7) random nodes placement model

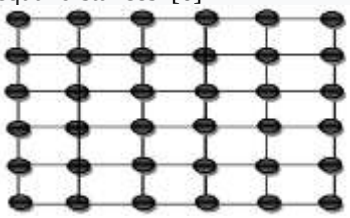


Figure (8) grid node placement model

2. SIMULATION ENVIRONMENT PARAMETER:

We will study effect increasing number of nodes on performance of geographical routing protocol using OPNET simulator with different traffic loads (Database, Email, FTP, HTTP, Video Conferencing, Voice) in case circular node placement model in terms of wireless local area network (WLAN) standards and GRP routing protocol standards and found in simulator statistics in a large network consists of 60 mobile nodes and in a small network consists of 30 mobile nodes. Table (2) shows the used simulation parameters.

Table (2) simulation parameters

Number of nodes	30 and 60
Network size	1000mx1000m
Simulation time	600 simulation seconds, seed=256,simulation kernel=optimized

Figures (9), (10), (11), (12), (13), (14) show properties of different traffic loads (Database, Email, FTP, HTTP, Video Conferencing, Voice) used in the simulation. Figures (15), (16), (17), (18), (19), (20) show properties of profiles of different traffic loads (Database, Email, FTP, HTTP, Video Conferencing, Voice) used in the simulation. Figures (21), (22), (23), (24), (25), (26) show properties of mobility in a large network and in a small network, properties of RXGroup, GRP protocol properties and wireless (LAN) parameters properties., applications and services according to the traffic load used on the server.

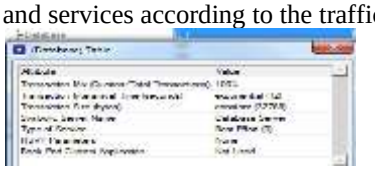


Figure (9): Database Application properties Used in simulation in case nodes were posited circularly, whether network was large or small

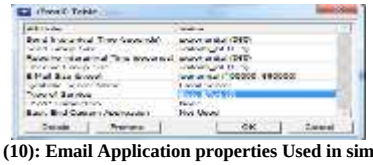


Figure (10): Email Application properties Used in simulation in case nodes were posited circularly,whether network was large or small

Figure (11): Video Application properties Used in simulation in case nodes were posited circularly,whether network was large or small

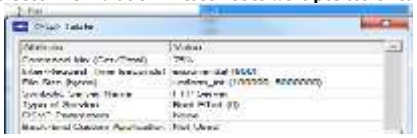


Figure (12): FTP Application properties Used in simulation in case nodes were posited circularly,whether network was large or small

Figure (13): HTTP Application properties Used in simulation in case nodes were posited circularly,whether network was large or small

Figure (14): Voice Application properties Used in simulation in case nodes were posited circularly,whether network was large or small

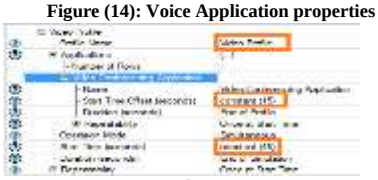


Figure (15): Video Profile properties Used in simulation in case nodes were posited circularly,whether network was large or small

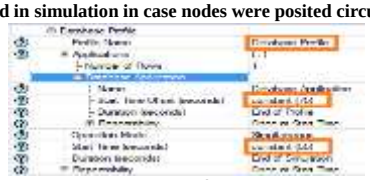


Figure (16): Database Profile properties Used in simulation in case nodes were posited circularly,whether network was large or small

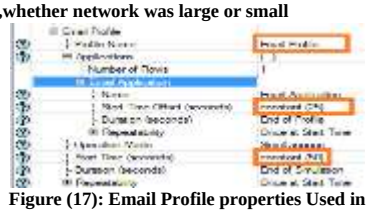


Figure (17): Email Profile properties Used in simulation in case nodes were posited circularly,whether network was large or small

Figure (18): FTP Profile properties Used in simulation in case nodes were posited circularly,whether network was large or small

Figure (19): HTTP Profile properties Used in simulation in case nodes were posited circularly,whether network was large or small

Figure (20): Voice Profile properties Used in simulation in case nodes were posited circularly,whether network was large or small

Figure (21): Mobility properties Used in simulation in network was large (1000x1000m, 60 nodes) in case nodes were posited circularly

Figure (22): Mobility properties Used in simulation in network was small (1000x1000m, 30 nodes) in case nodes were posited circularly

Figure (23): RXGroup properties Used in simulation in case nodes were posited circularly,whether network was large or small

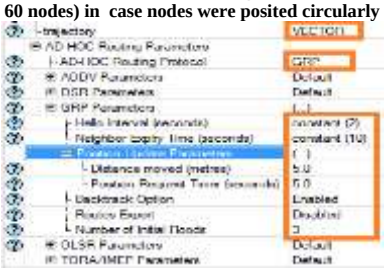


Figure (24): GRP routing properties in case nodes were posited circularly,whether network was large or small Used in all mobile nodes and the server

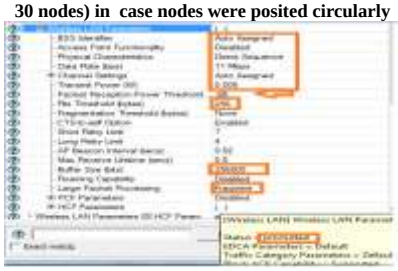


Figure (25): Wireless LAN parameters properties in case nodes were posited circularly,whether network was large or small Used in all mobile nodes and the server

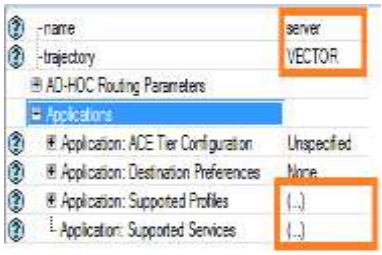


Figure (26): Applications and services according to the traffic load used on the server in case nodes were posited circularly, whether network was large or small

3. SIMULATION ENVIRONMENT

3.1 Topology In Case a Network Consists OF 30 Mobile Nodes And Used Protocol was GRP And Network Size was 1000x1000m In Case Circular Node Placement Model Regardless OF The Used Traffic Load:

Figure (27) shows topology in case a network consists of 30 mobile nodes and used protocol was GRP and network size was 1000x1000m in case circular node placement model regardless of the used traffic load.

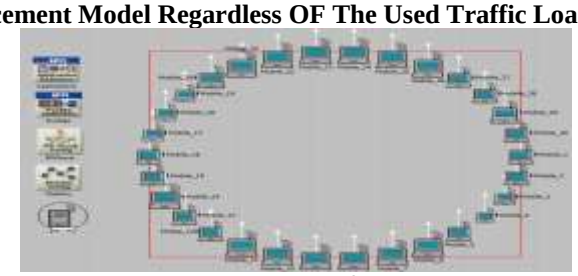


Figure (27) Topology in case a network consists of 30 mobile nodes and used protocol was GRP and network size was 1000x1000m in case circular node placement model regardless of the used traffic load.

3.2 Topology In Case a Network Consists OF 60 Mobile Nodes And Used Protocol was GRP And Network Size was 1000x1000m In Case Circular Node Placement Model Regardless OF The Used Traffic Load:

Figure (28) shows topology in case a network consists of 60 mobile nodes and used protocol was GRP and network size was 1000x1000m in case circular node placement model regardless of the used traffic load.

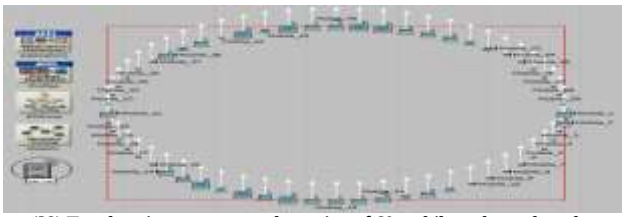


Figure (28) Topology in case a network consists of 60 mobile nodes and used protocol was GRP and network size was 1000x1000m in case circular node placement model regardless of the used traffic load.

4. RESULTS And DISCUSSION:

4.1 Evaluate Performance OF Geographical Routing Protocol In Case Circular Node Placement Model In a Small Network Consists OF 30 Mobile Nodes In Terms OF Wireless Local Area Network (WLAN) Standards And GRP Routing Protocol Standards For Different Traffic Loads.

Figures (29), (30), (31), (32) show wireless local area network (WLAN) standards in case number of nodes = 30 / Database application / nodes were posited circularly . Figures (33), (34), (35), (36), (37) show GRP protocol standards in case number of nodes = 30 / Database application / nodes were posited circularly . The values in Tables (3) and (4) will be explained later.

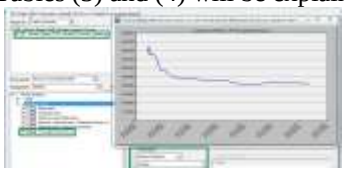


Figure (29) throughput in case number of nodes = 30 / Database application / nodes were posited circularly

Figure (30) Delay in case number of nodes = 30 / Database application /nodes were posited circularly

Figure (31) Load in case number of nodes = 30 / Database application / nodes were posited circularly

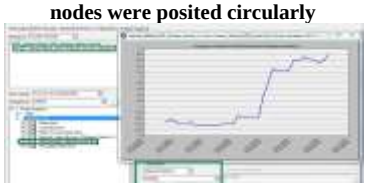


Figure (32) retransmission attempts in case number of nodes = 30 / Database application / nodes were posited circularly

Figure (33) routing traffic received in case number of nodes = 30 / Database application / nodes were posited circularly

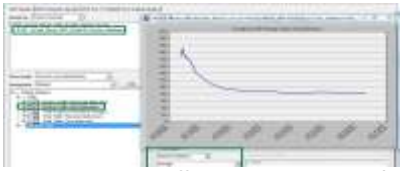


Fig. (34) routing traffic sent in case number of nodes = 30 / Database application / nodes were posited circularly

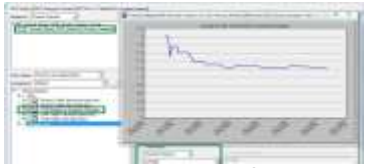


Figure (35) Total number of quadrant changes in case number of nodes = 30 / Database application / nodes were posited circularly

Figure (36) Total traffic received in case number of nodes = 30 / Database application / nodes were posited circularly

Figure (37) Total traffic sent in case number of nodes = 30 / Database application / nodes were posited circularly

Table (3) performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30/Database application / nodes were posited circularly.

Database Application						
Small network/30 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*237451.4123*	*0.001220377*	*63701.11597*	*1.256978471*

Table (4) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 / Database application / nodes were posited circularly.

Database Application							
Small network/30 nodes							
Routing protocols	***Node placement***		***routing traffic received***	***routing traffic sent***	***Total number of quadrant changes***	***Total traffic received***	***Total traffic sent***

GRP	*Circular*	***Aver.***	*370.1946166*	*98.11757613*	*1.335508654*	*370.1946166*	*98.11757613*

Figures (38), (39), (40), (41) show wireless local area network (WLAN) standards in case number of nodes = 30 / Video application / nodes were posited circularly . Figures (42), (43), (44), (45), (46) show GRP protocol standards in case number of nodes = 30 / Video application / nodes were posited circularly and the values in the tables (5), (6) will be explained later.

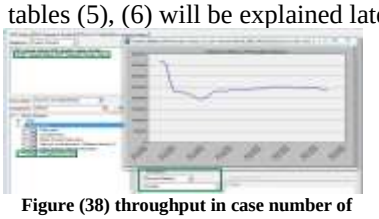


Figure (38) throughput in case number of nodes = 30 / Video application / nodes were posited circularly

Figure (39) delay in case number of nodes = 30 / Video application / nodes were posited circularly

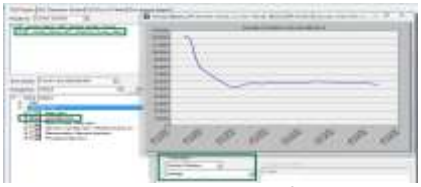


Figure (40) load in case number of nodes = 30 / Video application / nodes were posited circularly

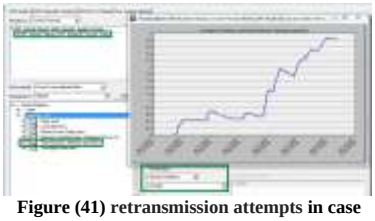


Figure (41) retransmission attempts in case number of nodes = 30 / Video application / nodes were posited circularly

Figure (42) routing traffic received in case number of nodes = 30 / Video application / nodes were posited circularly

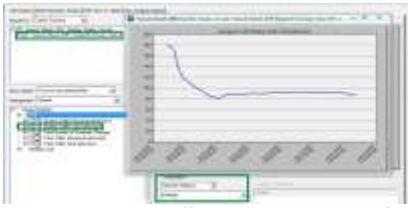


Fig. (43) routing traffic sent in case number of nodes = 30 / Video application / / nodes were posited circularly

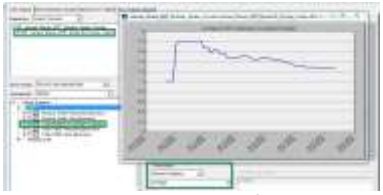


Figure (44) Total number of quadrant changes in case number of nodes = 30 / Video application / nodes were posited circularly

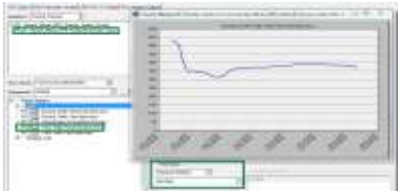


Figure (45) Total traffic received in case number of nodes = 30 / Video application / nodes were posited circularly

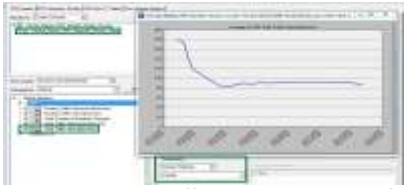


Figure (46) Total traffic sent in case number of nodes = 30 / Video application / nodes were posited circularly

Table (5) performance of Geographical routing protocol in terms of WLAN standards in case number of nodes = 30 / Video application / nodes were posited circularly

Video Application						
Small network/30 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*243312.1605*	*0.001310396*	*63104.60467*	*1.21930252*

Table (6) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 / video application /nodes were posited circularly

Video Application							
Small network/30 nodes							
Routing protocols	***Node placement***	***Aver.***	***routing traffic received***	***routing traffic sent***	***Total number of quadrant changes***	***Total traffic received***	***Total traffic sent***
GRP	*Circular*		*376.5138525*	*97.25663332*	*1.455355865*	*376.5138525*	*97.25663332*

Figures (47), (48), (49), (50) show wireless local area network (WLAN) standards in case number of nodes = 30 / Email application / nodes were posited circularly. Figures (51), (52), (53), (54), (55) show GRP protocol standards in case number of nodes = 30 / Email application / nodes were posited circularly and the values in Tables (7) and (8)will be explained later.

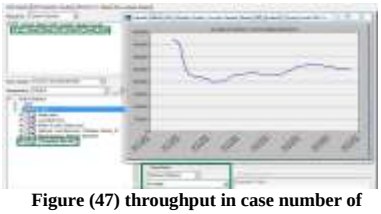


Figure (47) throughput in case number of nodes = 30 / Email application /nodes were posited circularly

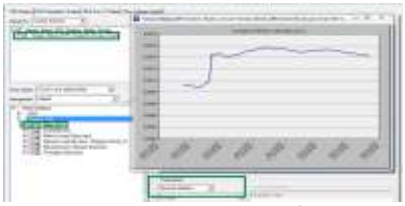


Figure (48) Delay in case number of nodes = 30 / Email application / nodes were posited circularly

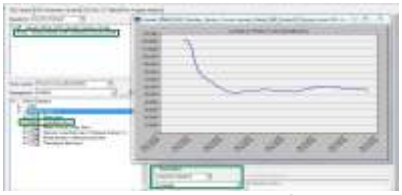


Figure (49) Load in case number of nodes = 30 / Email application / nodes were posited circularly

Figure (50) retransmission attempts in case number of nodes = 30 / Email application / nodes were posited circularly

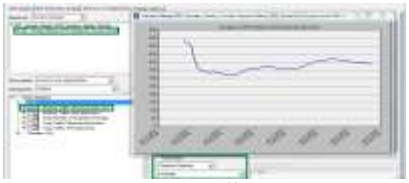


Figure (51) routing traffic received in case number of nodes = 30 / Email application / nodes were posited circularly

Figure (52) routing traffic sent in case number of nodes = 30 / Email application / / nodes were posited circularly

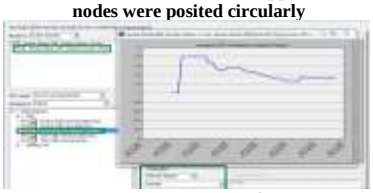


Figure (53) Total number of quadrant changes in case number of nodes = 30 / Email application / nodes were posited circularly

Figure (54) Total traffic received in case number of nodes = 30 / Email application / nodes were posited circularly

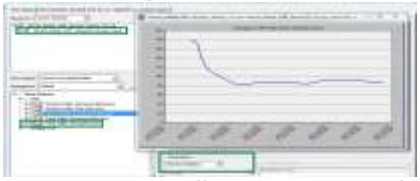


Figure (55) Total traffic sent in case number of nodes = 30 / Email application / nodes were posited circularly

Table (7) performance of geographical routing protocol in terms of WLAN standards in case number of nodes = 30 / Email application/ nodes were posited circularly

Email Application						
Small network/30 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*244440.7908*	*0.001404709*	*61945.85603*	*1.156570704*

Table (8) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 / Email application /nodes were posited circularly

Email Application							
Small network/30 nodes							
Routing protocols	***Node placement***	***Aver.***	***routing traffic received***	***routing traffic sent***	***Total number of quadrant changes***	***Total traffic received***	***Total traffic sent***
GRP	*Circular*		*377.9733134*	*95.59094073*	*1.444745097*	*377.9733134*	***95.59094073***

Figures (56), (57), (58), (59) show wireless local area network (WLAN) standards in case number of nodes = 30 / FTP application / nodes were posited circularly. Figures (60), (61), (62), (63), (64) show GRP protocol standards in case number of nodes = 30 / FTP application / nodes were posited circularly and the values in Tables (9) and (10) will be explained later.

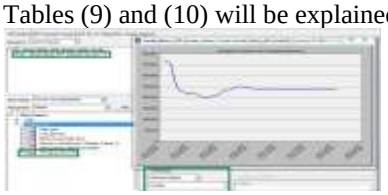


Figure (56) throughput in case number of nodes = 30 / FTP application / nodes were posited circularly

Figure (57) Delay in case number of nodes = 30 / FTP application / nodes were posited circularly

Figure (58) Load in case number of nodes = 30 / FTP application / nodes were posited circularly

Figure (59) retransmission attempts in case number of nodes = 30 / FTP application / nodes were posited circularly

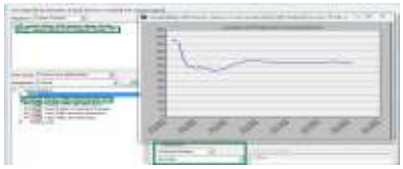


Figure (60) routing traffic received in case number of nodes = 30 / FTP application / nodes were posited circularly

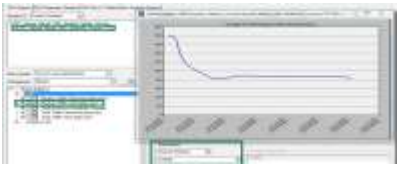


Figure (61) routing traffic sent in case number of number of nodes = 30 / FTP application / nodes were posited circularly

Figure (62) Total number of quadrant changes in case number of nodes = 30 / FTP application / nodes were posited circularly

Figure (63) Total traffic received in case number of nodes = 30 / FTP application / nodes were posited circularly

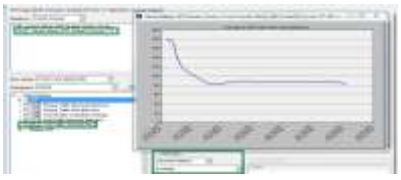


Figure (64) Total traffic sent in case number of nodes = 30 / FTP application / nodes were posited circularly

Table(9) Performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 / FTP application / nodes were posited circularly

FTP Application						
Small network/30 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*239656.9158*	*0.001466251*	*61358.55325*	*0.91575461*

Table (10) performance of Geographical routing protocol in terms of GRP standards in case number of nodes = 30 / FTP application /nodes were posited circularly

FTP Application							
Small network/30 nodes							
Routing protocols	***Node placement***	***Aver.***	*routing traffic received*	*routing traffic sent*	*Total number of quadrant changes*	*Total traffic received*	*Total traffic sent*
GRP	*Circular*		*372.8492473*	*94.68429802*	*1.432573321*	*372.8492473*	*94.68429802*

Figures (65), (66), (67), (68) show wireless local area network (WLAN) standards in case number of nodes = 30 / HTTP application / nodes were posited circularly. Figures (69), (70), (71), (72), (73) show GRP protocol standards in case number of nodes = 30 / HTTP application / nodes were posited circularly and the values in Tables (11) and (12) will be explained later.

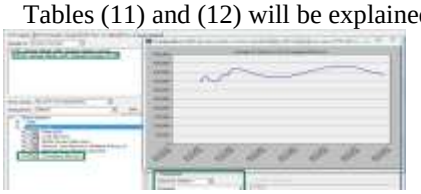


Figure (65) throughput in case number of nodes = 30 / HTTP application / nodes were posited circularly

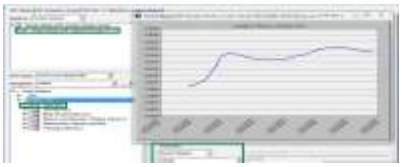


Figure (66) delay in case number of nodes = 30 / HTTP application / nodes were posited circularly

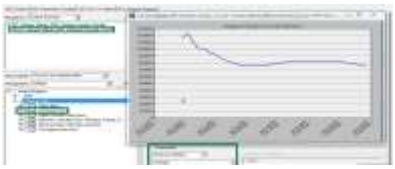
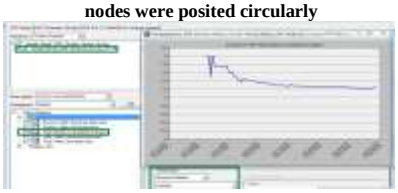


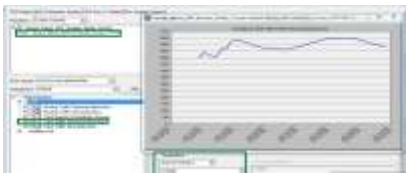
Figure (67) Load in case number of nodes = 30 / HTTP application / nodes were posited circularly

Figure (68) retransmission attempts in case number of nodes = 30 / HTTP application / nodes were posited circularly

Fig. (69) routing traffic received in case number of nodes = 30 / HTTP application / nodes were posited circularly

Figure (70) routing traffic sent in case number of nodes = 30 / HTTP application / nodes were posited circularly





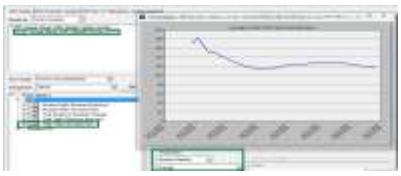


Figure (71) Total number of quadrant changes in case number of nodes = 30 / HTTP application / nodes were posited circularly

Figure (72) Total traffic received in case number of nodes = 30 / HTTP application / nodes were posited circularly

Figure (73) Total traffic sent in case number of nodes = 30 / HTTP application / nodes were posited circularly

Table (11) performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 / HTTP application /nodes were posited circularly

HTTP Application						
Small network/30 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*395806.1863*	*0.001717638*	*85113.52582*	*1.504257137*

Table (12) performance of geographical routing protocol in terms of GRP standards in case number of nodes = 30 / HTTP application / nodes were posited circularly

HTTP Application							
Small network/30 nodes							
Routing protocols	***Node placement***	***Aver.***	***routing traffic received***	***routing traffic sent***	***Total number of quadrant changes***	***Total traffic received***	***Total traffic sent***
GRP	*Circular*		*595.4934672*	*129.6109994*	*1.374189751*	*595.4934672*	*129.6109994*

Figures (74), (75), (76), (77) show wireless local area network (WLAN) standards in case number of nodes = 30 / Voice application / nodes were posited circularly. Figures (78), (79), (80), (81), (82) show GRP protocol standards in case number of nodes = 30 / Voice application / nodes were posited circularly and the values in Tables (13) and (14) will be explained later.

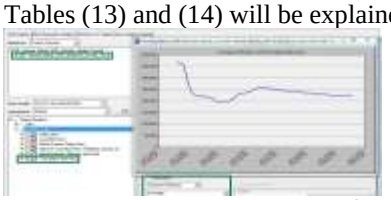


Figure (74) throughput in case number of nodes = 30 / Voice application / nodes were posited circularly

Figure (75) delay in case number of nodes = 30 / Voice application / nodes were posited circularly

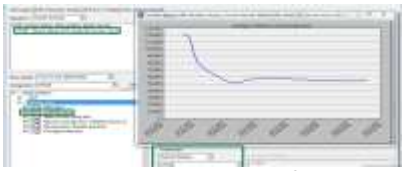


Figure (76) Load in case number of nodes = 30 / Voice application / nodes were posited circularly

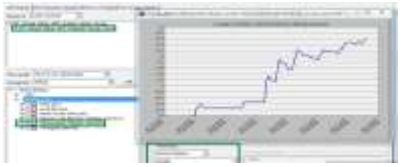


Figure (77) retransmission attempts in case number of nodes = 30 / Voice application / nodes were posited circularly

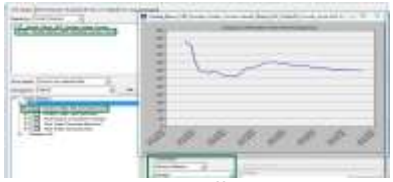


Figure (78) routing traffic received in case number of nodes = 30 / Voice application / nodes were posited circularly

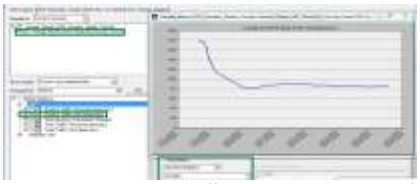


Figure (79) routing traffic sent in case number of nodes = 30 / Voice application / nodes were posited circularly

Figure (80) Total number of quadrant changes in case number of nodes = 30 / Voice application / nodes were posited circularly

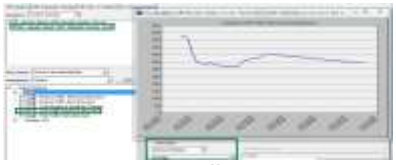


Figure (81) Total traffic received in case number of nodes = 30 / Voice application / nodes were posited circularly

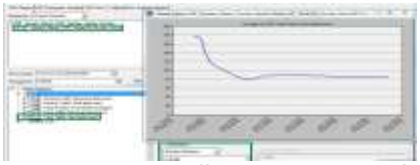


Figure (82) Total traffic sent in case number of nodes = 30 / Voice application / nodes were posited circularly

Table (13) performance of Geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 / Voice application / nodes were posited circularly

Voice Application						
Small network/30 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*237757.0663*	*0.001415862*	*61236.94079*	*1.28281748*

Table (14) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 / Voice application / nodes were posited circularly

Voice Application
Small network/30 nodes

Routing protocols	Node placement	Aver.	routing traffic received	routing traffic sent	Total number of quadrant changes	Total traffic received	Total traffic sent
GRP	Circular		369.9717493	94.51922261	1.563172144	369.9717493	94.51922261

4.2 Evaluate Performance OF Geographical Routing Protocol In Case Circular Node Placement Model In a Large Network Consists OF 60 Mobile Nodes In Terms OF Wireless Local Area Network (WLAN) Standards And GRP Routing Protocol Standards For Different Traffic Loads.

Figures (83), (84), (85), (86) show wireless local area network (WLAN) standards in case number of nodes = 60 / Database application / nodes were posited circularly. Figures (87), (88), (89), (90), (91) show GRP protocol standards in case number of nodes = 60 / Database application / nodes were posited circularly and the values in Tables (15) and (16) will be explained later.

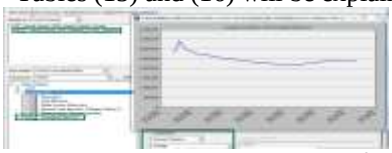


Figure (83) throughput in case number of nodes = 60 / Database application / nodes were posited circularly

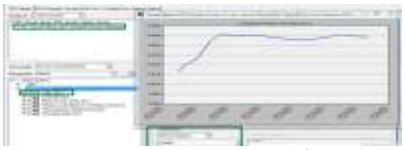


Figure (84) Delay in case number of nodes = 60 / Database application/ nodes were posited circularly

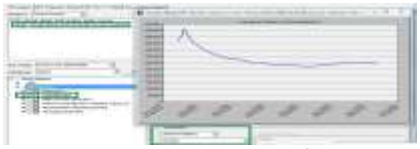


Figure (85) Load in case number of nodes = 60 / Database application / nodes were posited circularly

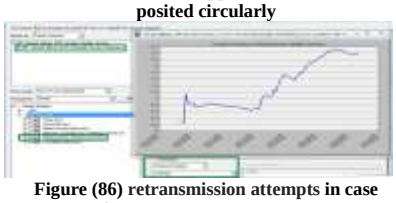


Figure (86) retransmission attempts in case number of nodes = 60 / Database application / nodes were posited circularly

Fig. (87) routing traffic received in case number of nodes = 60 / Database application / nodes were posited circularly

Figure (88) routing traffic sent in case number of nodes = 60 / Database application / nodes were posited circularly

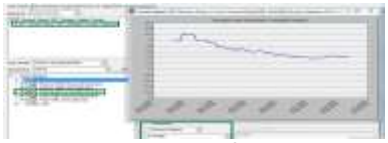


Figure (89) Total number of quadrant changes in case number of nodes = 60 / Database application / nodes were posited circularly

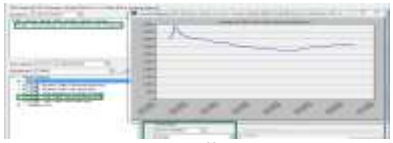


Figure (90) Total traffic received in case number of nodes = 60 / Database application / nodes were posited circularly

Figure (91) Total traffic sent in case number of nodes = 60 / Database application / nodes were posited circularly

Table (15) Performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 60 / Database application / nodes were posited circularly

Database Application						
large network/60 nodes						
Routing protocols	Node placement	Aver.	throughput	Delay	Load	retransmission attempts
GRP	Circular		2450557.179	0.003219418	327082.5066	1.396954455

Table (16) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 60 / Database application / nodes were posited circularly

Database Application							
large network/60 nodes							
Routing protocols	Node placemen	Aver.	routing traffic received	routing traffic sent	Total number of quadrant changes	Total traffic received	Total traffic sent
GRP	Circular		3644.786637	488.7674999	1.648237348	3644.786637	488.7674999

Figures (92), (93), (94), (95) show wireless local area network (WLAN) standards in case number of nodes = 60 / Video application / nodes were posited circularly. Figures (96), (97), (98), (99), (100) show GRP protocol standards in case number of nodes = 60 / Video application / nodes were posited circularly. The values in Tables (17) and (18) will be explained later.

Figure (92) throughput in case number of nodes = 60 / Video application / nodes were posited circularly

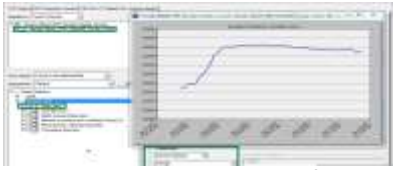


Figure (93) Delay in case number of nodes = 60 / Video application / nodes were posited circularly

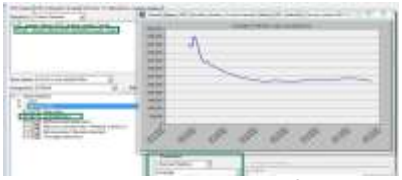


Figure (94) Load in case number of nodes = 60 / Video application / nodes were posited circularly

Figure (95) retransmission attempts in case number of nodes = 60 / Video application / nodes were posited circularly

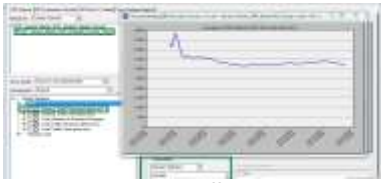


Figure (96) routing traffic received in case number of nodes = 60 / Video application / nodes were posited circularly

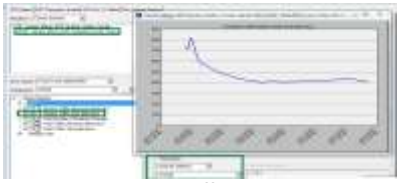


Figure (97) routing traffic sent in case number of nodes = 60 / Video application / nodes were posited circularly

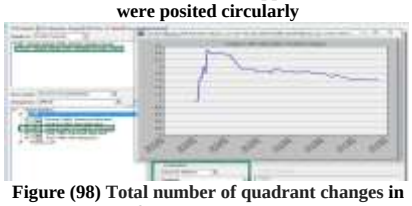


Figure (98) Total number of quadrant changes in case number of nodes = 60 / Video application / nodes were posited circularly

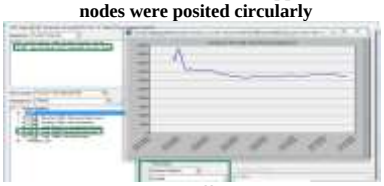


Figure (99) Total traffic received in case number of nodes = 60 / Video application / nodes were posited circularly

Figure (100) Total traffic sent in case number of nodes = 60 / Video application / nodes were posited circularly

Table (17) performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 60 / Video application / nodes were posited circularly

Video Application						
large network/60 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*2261637.01*	*0.003638627*	*307093.9738*	*1.264015594*

Table (18) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 60 / Video application / nodes were posited circularly

Video Application							
large network/60 nodes							
Routing protocol	***Node placemen***	***Aver.***	*routing traffic received*	*routing traffic sent*	*Total number of quadrant changes*	*Total traffic received*	*Total traffic sent*
GRP	*Circular*		*3398.629644*	*459.2437998*	*1.854073839*	*3398.629644*	*459.2437998*

Figures (101), (102), (103), (104) show wireless local area network (WLAN) standards in case number of nodes = 60 / Email application / nodes were posited circularly. Figures (105), (106), (107), (108), (109) show GRP protocol standards in case number of nodes = 60 / Email application / nodes were posited circularly and the values in Tables (19) and (20) will be explained later.

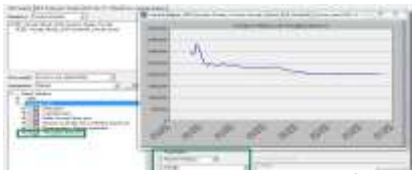


Figure (101) throughput in case number of nodes = 60 / Email application / nodes were posited circularly

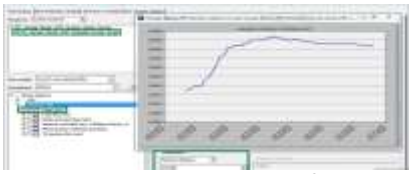


Figure (102) Delay in case number of nodes = 60 / Email application / nodes were posited circularly

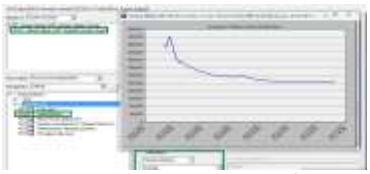


Figure (103) Load in case number of nodes = 60 / Email application / nodes were posited circularly

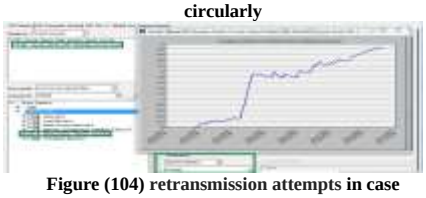


Figure (104) retransmission attempts in case number of nodes = 60 / Email application / nodes were posited circularly

Figure (105) routing traffic received in case number of nodes = 60 / Email application / nodes were posited circularly

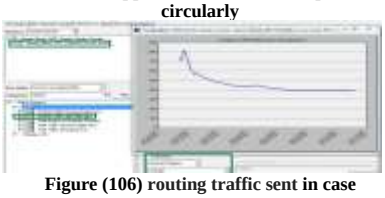


Figure (106) routing traffic sent in case number of nodes = 60 / Email application / nodes were posited circularly

Figure (107) Total number of quadrant changes in case number of nodes = 60 / Email application / nodes were posited circularly

Figure (108) Total traffic received in case number of nodes = 60 / Email application / nodes were posited circularly

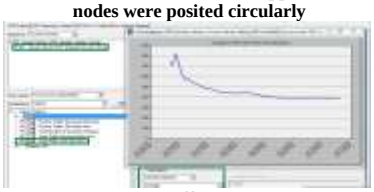


Figure (109) Total traffic sent in case number of nodes = 60 / Email application / nodes were posited circularly

Table (19) performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 60 / Email application /nodes were posited circularly

Email Application						
large network/60 nodes						
Routing protocol	Node placement	Aver.	throughput	Delay	Load	retransmission attempts
GRP	Circular		2243674.981	0.003962344	304654.5709	1.63853039

Table (20) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 60 / Email application / nodes were posited circularly

Email Application							
large network/60 nodes							
Routing protocol	Node placement	Aver.	routing traffic received	routing traffic sent	Total number of quadrant changes	Total traffic received	Total traffic sent
GRP	Circular		3373.509511	455.7300672	1.737028769	3373.509511	455.7300672

Figures (110), (111), (112), (113) show wireless local area network (WLAN) standards in case number of nodes = 60 / FTP application / nodes were posited circularly. Figures (114), (115), (116), (117), (118) show GRP protocol standards in case number of nodes = 60 / FTP application / nodes were posited circularly. The values in Tables (21) and (22) will be explained later.

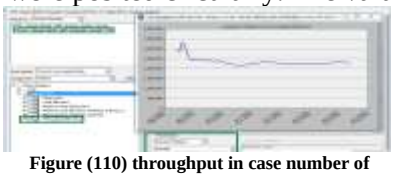


Figure (110) throughput in case number of nodes = 60 / FTP application / nodes were posited circularly

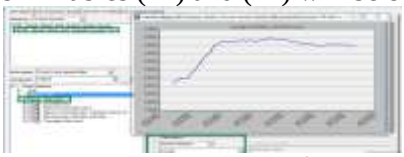


Figure (111) delay in case number of nodes = 60 / FTP application / nodes were posited circularly

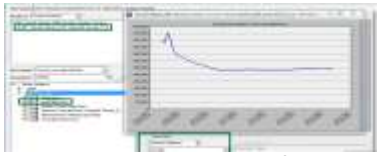


Figure (112) Load in case number of nodes = 60 / FTP application / nodes were posited circularly

Figure (113) retransmission attempts in case number of nodes = 60 / FTP application / nodes were posited circularly

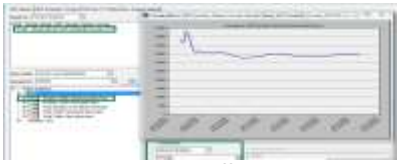


Figure (114) routing traffic received in case number of nodes = 60 / FTP application / nodes were posited circularly

Figure (115) routing traffic sent in case number of nodes = 60 / FTP application / nodes were posited circularly

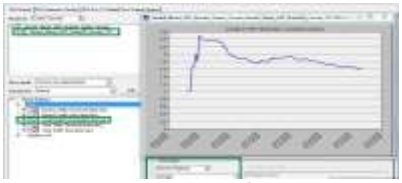


Figure (116) Total number of quadrant changes in case number of nodes = 60 / FTP application / nodes were posited circularly

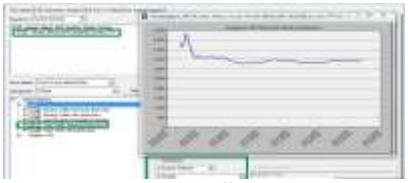


Figure (117) Total traffic received in case number of nodes = 60 / FTP application / nodes were posited circularly

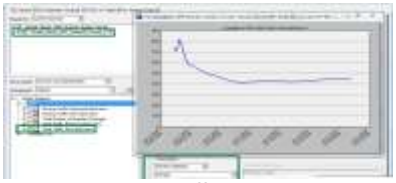


Figure (118) Total traffic sent in case number of nodes = 60 / FTP application / nodes were posited circularly

Table (21) performance of Geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 60 / FTP application / nodes were posited circularly

FTP Application						
large network/60 nodes						
Routing protocols	Node placement	Aver.	throughput	Delay	Load	retransmission attempts
GRP	Circular		2331381.159	0.003788859	313845.3803	1.044857894

Table (22) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 60 / FTP application / nodes were posited circularly

FTP Application							
large network/60 nodes							
Routing protocols	Node placement	Aver.	routing traffic received	routing traffic sent	Total number of quadrant changes	Total traffic received	Total traffic sent
GRP	Circular		3499.067196	469.146559	1.863382695	3499.067196	469.1465591

Figures (119), (120), (121), (122) show wireless local area network (WLAN) standards in case number of nodes = 60 / HTTP application / nodes were posited circularly. Figures (123), (124), (125), (126), (127) show

GRP protocol standards in case number of nodes = 60 / HTTP application / nodes were posited circularly and the values in Tables (23) and (24) will be explained later.

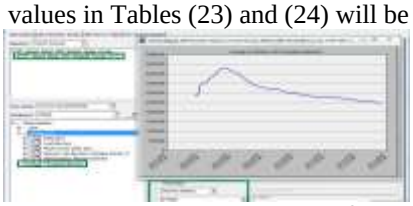


Figure (119) throughput in case number of nodes = 60 / HTTP application / nodes were posited circularly

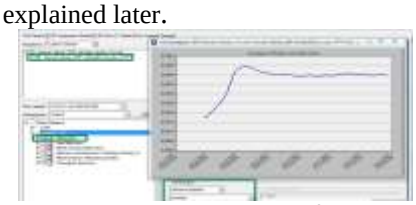


Figure (120) delay in case number of nodes = 60 / HTTP application / nodes were posited circularly

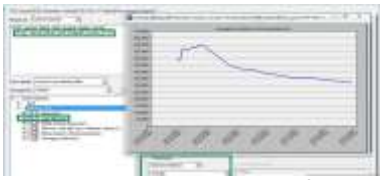


Figure (121) Load in case number of nodes = 60 / HTTP application / nodes were posited circularly

Figure (122) retransmission attempts in case number of nodes = 60 / HTTP application / nodes were posited circularly

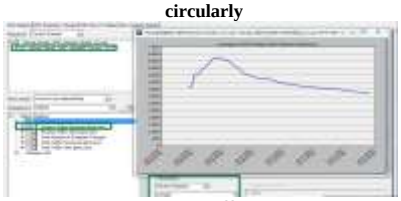


Figure (123) routing traffic received in case number of nodes = 60 / HTTP application / nodes were posited circularly

Figure (124) routing traffic sent in case number of nodes = 60 / HTTP application / nodes were posited circularly

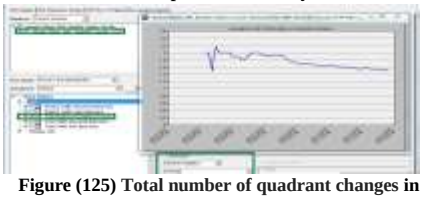


Figure (125) Total number of quadrant changes in case number of nodes = 60 / HTTP application / nodes were posited circularly

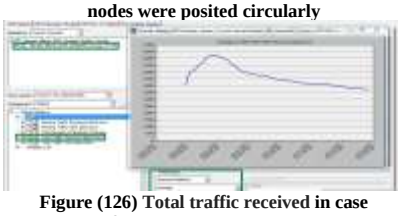


Figure (126) Total traffic received in case number of nodes = 60 / HTTP application / nodes were posited circularly

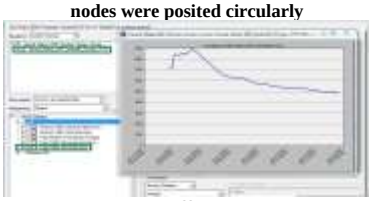


Figure (127) Total traffic sent in case number of nodes = 60 / HTTP application / nodes were posited circularly

Table (23) performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 60 / HTTP application / nodes were posited circularly

HTTP Application						
large network/60 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*3144554.302*	*0.003794869*	*422923.7144*	*1.22924915*

Table (24) performance of geographical routing protocol in terms of GRP standards in case number of nodes = 60 / HTTP application / nodes were posited circularly

HTTP Application							
large network/60 nodes							
Routing protocols	***Node placement***	***Aver.***	***routing traffic received***	***routing traffic sent***	***Total number of quadrant changes***	***Total traffic received***	***Total traffic sent***
GRP	*Circular*		*4660.047693*	*629.7793783*	*1.758735336*	*4660.047693*	*629.7793783*

Figures (128), (129), (130), (131) show wireless local area network (WLAN) standards in case number of nodes = 60 / Voice application / nodes were posited circularly. Figures (132), (133), (134), (135), (136) show GRP protocol standards in case number of nodes = 60 / Voice application / nodes were posited circularly and the values in tables (25) and (26) will be explained later.

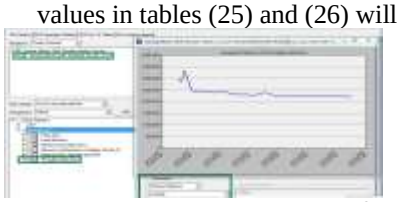


Figure (128) throughput in case number of nodes = 60 / Voice application/nodes were posited circularly

Figure (129) Delay in case number of nodes = 60 / Voice application/nodes were posited circularly

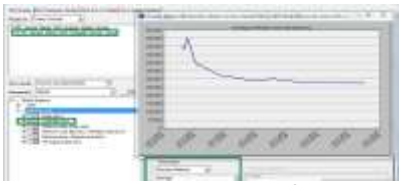


Figure (130) Load in case number of nodes = 60 / Voice application/nodes were posited circularly

Figure (131) retransmission attempts in case number of nodes =60 / Voice application /

Figure (132) routing traffic received in case number of nodes = 60 / Voice application / nodes were posited

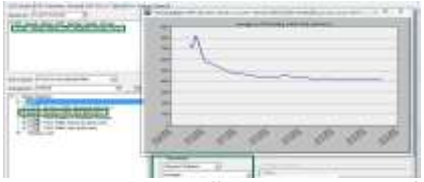


Figure (133) routing traffic sent in case number of nodes = 60 / Voice application / nodes were posited

nodes were posited circularly

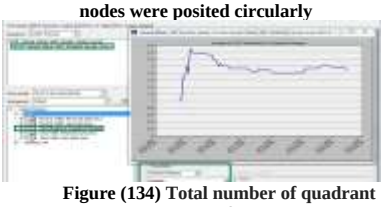


Figure (134) Total number of quadrant changes in case number of nodes = 60 / Voice application / nodes were posited circularly

circularly

Figure (135) Total traffic received in case number of nodes = 60 / Voice application / nodes were posited circularly

circularly

Figure (136) Total traffic sent in case number of nodes = 60 / Voice application / nodes were posited circularly

Table (25) performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 60 / Voice application /nodes were posited circularly

Voice Application						
large network/60 nodes						
Routing protocols	***Node placement***	***Aver.***	***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*Circular*		*2348156.112*	*0.003798689*	*315152.636*	*1.285489577*

Table (26) performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 60 / Voice application / nodes were posited circularly

Voice Application							
large network/60 nodes							
Routing protocol	***Node placement***	***Aver.***	***routing traffic received***	***routing traffic sent***	***Total number of quadrant changes***	***Total traffic received***	***Total traffic sent***
GRP	*Circular*		*3526.013287*	*471.0980398*	*1.946573209*	*3526.013287*	*471.0980398*

4.3 Study And Comparison Effect Increasing Number OF Nodes On Performance OF Geographic Routing Protocol In a Small Network Consists OF 30 Mobile Nodes In Case Circular Node Placement Model And Between Its Performance In a Large Network Consists OF 60 Mobile Nodes In Case Circular Node Placement Model Also In Terms OF Wireless Local Area network (WLAN) Standards And GRP Standards For Various Traffic Loads.

Figures (137), (138), (139), (140) show wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly. Figures (141), (142), (143), (144), (145) show GRP protocol standards in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly. The values in Tables (27) and (28) will be explained later.

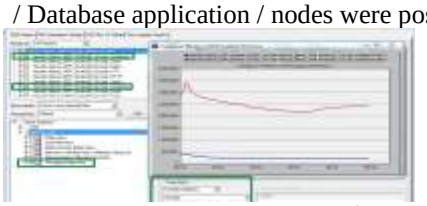


Figure (137) throughput in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly

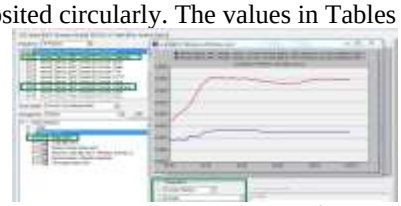


Figure (138) delay in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly

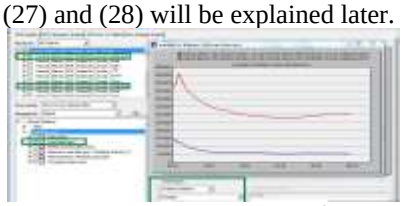


Figure (139) Load in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly

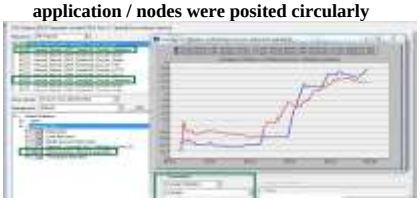


Figure (140) retransmission attempts in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly

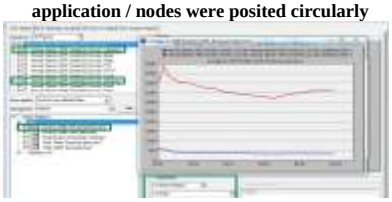


Figure (141) routing traffic received in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly

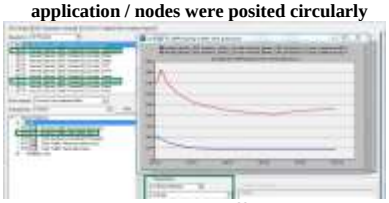


Figure (142) routing traffic sent in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly

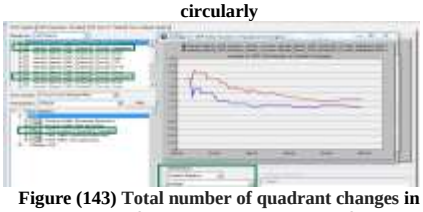


Figure (143) Total number of quadrant changes in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly

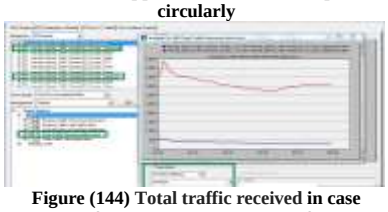


Figure (144) Total traffic received in case number of nodes = 30 and number of nodes = 60 / Database application /nodes were posited circularly

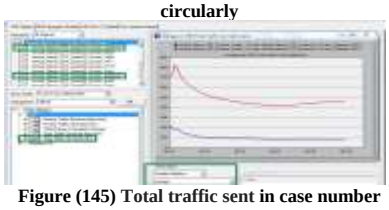


Figure (145) Total traffic sent in case number of nodes = 30 and number of nodes = 60 / Database application / nodes were posited circularly

Table (27) Comparison performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for Database application

Database Application

Routing protocols	Node placement	Number of Nodes		throughput	Delay	Load	retransmission attempts
GRP	circular	30	Aver.	237451.4123	0.001220377	63701.11597	1.256978471
		60		2450557.179	0.003219418	327082.5066	1.396954455

Table (28) Comparison performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 and number of nodes =60 and nodes were posited circularly, but for Database application

Database Application								
Routing protocols	Node placement	Number of Nodes		routing traffic received	routing traffic sent	Total number of quadrant changes	Total traffic received	Total traffic sent
GRP	circular	30	Aver.	370.1946166	98.11757613	1.335508654	370.1946166	98.11757613
		60		3644.786637	488.7674999	1.648237348	3644.786637	488.7674999

Figures (146), (147), (148), (149) show wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 / Video application / nodes were posited circularly. Figures (150), (151), (152), (153), (154) show GRP protocol standards in case number of nodes = 30 and number of nodes = 60 / video application / nodes were posited circularly and the values in Tables (29) and (30) will be explained later.

Figure (146) throughput in case number of nodes = 30 and number of nodes = 60 / video application / nodes were posited circularly

Figure (147) Delay in case number of nodes = 30 and number of nodes = 60 / Video application / nodes were posited circularly

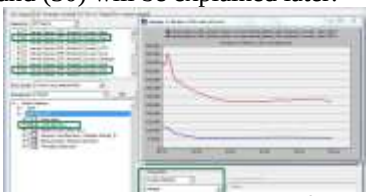


Figure (148) Load in case number of nodes = 30 and number of nodes = 60 / Video application / nodes were posited circularly

Figure (149) retransmission attempts in case number of nodes = 30 and number of nodes = 60 / Video application / nodes were posited circularly

Figure (150) routing traffic received in case number of nodes = 30 and number of nodes = 60 / video application / nodes were posited circularly

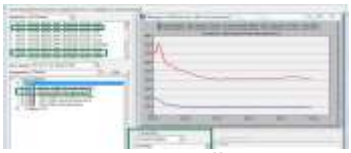


Figure (151) routing traffic sent in case number of nodes = 30 and number of nodes = 60 / Video application / nodes were posited circularly

Figure (152) Total number of quadrant changes in case number of nodes = 30 and number of nodes = 60 / Video application / nodes were posited circularly

Figure (153) Total traffic received in case number of nodes = 30 and number of nodes = 60 / Video application / nodes were posited circularly

Figure (154) Total traffic sent in case number of nodes = 30 and number of nodes = 60 / Video application / nodes were posited circularly

Table (29) Comparison performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for Video application

Video Application							
Routing protocol	Node placement	Number of Nodes		throughput	Delay	Load	retransmission attempts
GRP	circular	30	Aver.	243312.1605	0.001310396	63104.60467	1.21930252
		60		2261637.01	0.003638627	307093.9738	1.264015594

Table (30) Comparison performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for Video application

Video Application								
Routing protocols	Node placement	Number of Nodes		routing traffic received	routing traffic sent	Total number of quadrant changes	Total traffic received	Total traffic sent
GRP	circular	30		376.5138525	97.25663332	1.455355865	376.5138525	97.25663332

		60	***Aver.***	*3398.629644*	*459.2437998*	*1.854073839*	*3398.629644*	*459.2437998*

Figures (155), (156), (157), (158) show wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly. Figures (159), (160), (161), (162), (163) show GRP protocol standards in case number of nodes = 30 and number of nodes = 60 / Email application /nodes were posited circularly and the values in Tables (31) and (32) will be explained later.

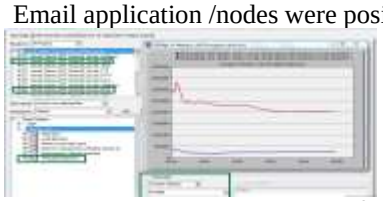


Figure (155) throughput in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly

Figure (156) Delay in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly

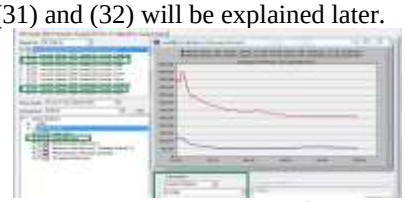


Figure (157) Load in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly

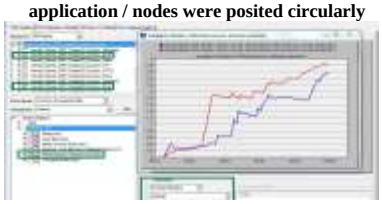


Figure (158) retransmission attempts in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly

Figure (159) routing traffic received in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly

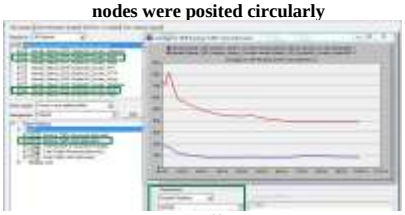


Figure (160) routing traffic sent in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly

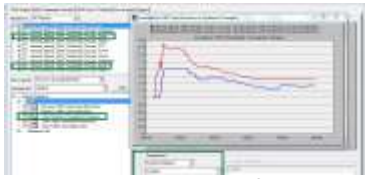


Figure (161) Total number of quadrant changes in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly

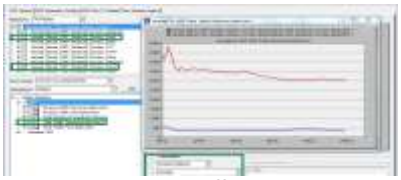


Figure (162) Total traffic received in case number of nodes = 30 and number of nodes = 60 / Email application /nodes were posited circularly

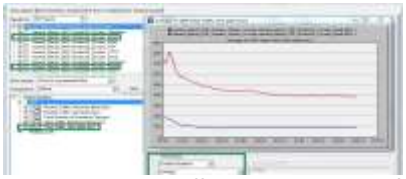


Figure (163) Total traffic sent in case number of nodes = 30 and number of nodes = 60 / Email application / nodes were posited circularly

Table (31) Comparison performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for Email application.

Email Application							
Routing protocols	***Node placement***	***Number of Nodes***		**throughput**	**Delay**	**Load**	**retransmission attempts**
GRP	*circular*	***30***	***Aver.***	*244440.7908*	*0.001404709*	*61945.85603*	*1.156570704*
		60		*2243674.981*	*0.003962344*	*304654.5709*	*1.63853039*

Table (32) Comparison performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for Email application.

Email Application								
Routing protocols	***Node placement***	***Number of Nodes***		**routing traffic received**	**routing traffic sent**	**Total number of quadrant changes**	**Total traffic received**	**Total traffic sent**
GRP	*circular*	*30*	***Aver.***	*377.9733134*	*95.59094073*	*1.444745097*	*377.9733134*	*95.59094073*
		60		*3373.509511*	*455.7300672*	*1.737028769*	*3373.509511*	*455.7300672*

Figures (164), (165), (166), (167) show wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly. Figures (168), (169), (170), (171), (172) show GRP protocol standards in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly and the values in tables (33) and (34) will be explained later.

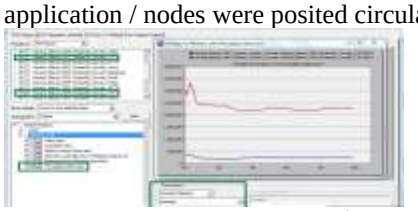


Figure (164) throughput in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

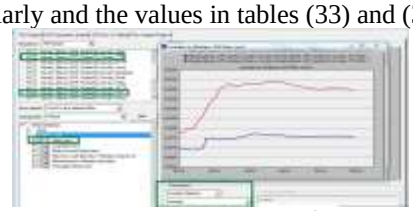


Figure (165) Delay in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

Figure (166) Load in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

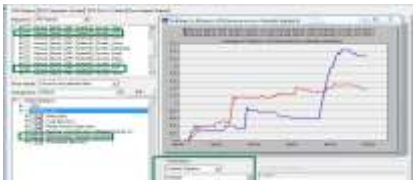


Figure (167) retransmission attempts in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

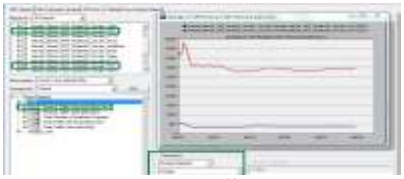


Figure (168) routing traffic received in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

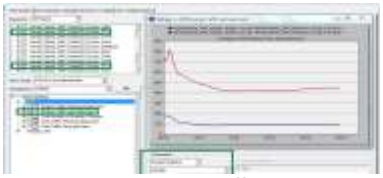


Figure (169) routing traffic sent in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

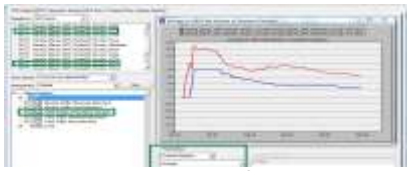


Figure (170) Total number of quadrant changes in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

Figure (171) Total traffic received in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

Figure (172) Total traffic sent in case number of nodes = 30 and number of nodes = 60 / FTP application / nodes were posited circularly

Table (33) Comparison performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for FTP application .

FTP Application							
Routing protocols	***Node placement***	***Number of Nodes***		***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*circular*	*30*	***Aver.***	*239656.9158*	*0.001466251*	*61358.55325*	*0.91575461*
		60		*2331381.159*	*0.003788859*	*313845.3803*	*1.044857894*

Table (34) Comparison performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for FTP application

FTP Application								
Routing protocols	***Node placement***	***Number of Nodes***		*routing traffic received*	*routing traffic sent*	*Total number of quadrant changes*	*Total traffic received*	*Total traffic sent*
GRP	*circular*	***30***	***Aver .***	*372.8492473*	*94.68429802*	*1.432573321*	*372.8492473*	*94.68429802*
		60		*3499.067196*	*469.1465591*	*1.863382695*	*3499.067196*	*469.1465591*

Figures (173), (174), (175), (176) show wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly. Figures (177),(178), (179), (180), (181) show GRP protocol standards in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly. Tables (35) and (36) and will be explained later.

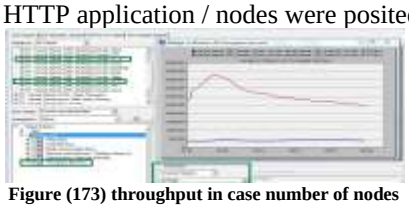


Figure (173) throughput in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

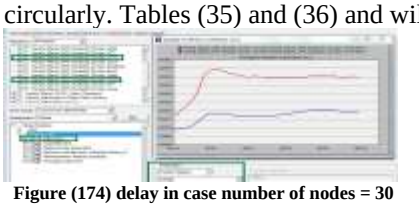


Figure (174) delay in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

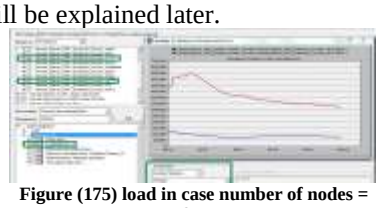


Figure (175) load in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

Figure (176) retransmission attempts in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

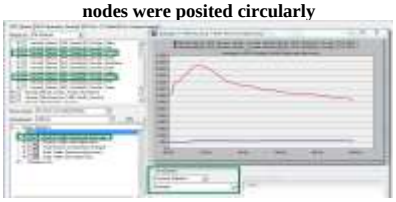


Figure (177) routing traffic received in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

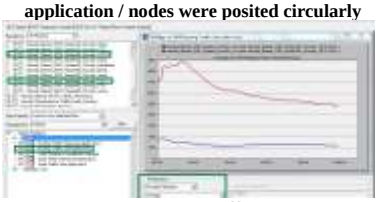


Figure (178) routing traffic sent in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

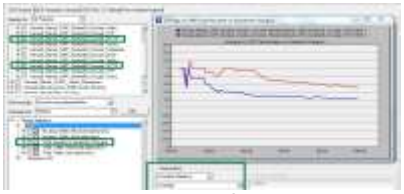


Figure (179) Total number of quadrant changes in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

Figure (180) Total traffic received in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

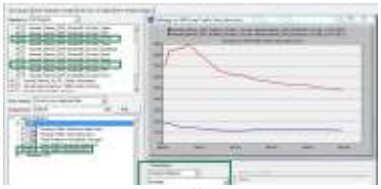


Figure (181) Total traffic sent in case number of nodes = 30 and number of nodes = 60 / HTTP application / nodes were posited circularly

Table (35) Comparison performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for HTTP application .

HTTP Application							
Routing protocols	***Node placement***	***Number of Nodes***		***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*circular*	*30*	***Aver.***	*395806.1863*	*0.001717638*	*85113.52582*	*1.504257137*
		60		*3144554.302*	*0.003794869*	*422923.7144*	*1.22924915*

Table (36) Comparison performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for HTTP application

HTTP Application								
Routing protocols	***Node placement***	***Number of Nodes***		*routing traffic received*	*routing traffic sent*	*Total number of quadrant changes*	*Total traffic received*	*Total traffic sent*
GRP	*circular*	*30*	***Aver.***	*595.4934672*	*129.6109994*	*1.374189751*	*595.4934672*	*129.6109994*
		60		*4660.047693*	*629.7793783*	*1.758735336*	*4660.047693*	*629.7793783*

Figures (182), (183), (184), (185) show wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 / Voice application / nodes were posited circularly. Figures (186),(187), (188), (189), (190) show GRP protocol standards in case number of nodes = 30 and number of nodes = 60 / Voice application / nodes were posited circularly. Tables (37) and (38) will be explained later.

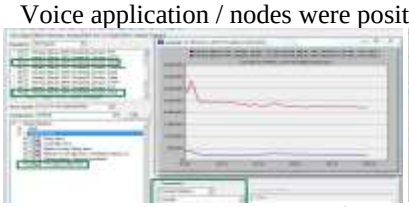


Figure (182) throughput in case number of nodes = 30 and number of nodes = 60 / Voice application / nodes were posited circularly

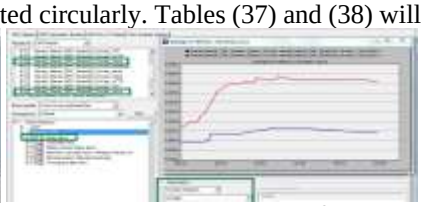


Figure (183) Delay in case number of nodes = 30 and number of nodes = 60 / Voice application / nodes were posited circularly

Figure (184) Load in case number of nodes = 30 and number of nodes = 60 / Voice application / nodes were posited circularly

Figure (185) retransmission attempts in case number of nodes = 30 and number of nodes = 60 / Voice application / nodes were posited circularly

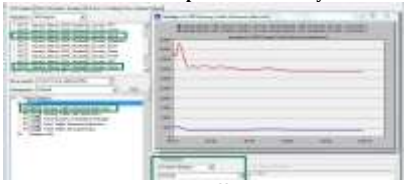


Fig. (186) routing traffic received in case number of nodes = 30 and number of nodes = 60 / Voice application/ nodes were posited circularly

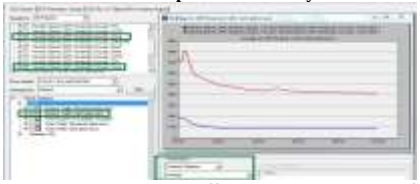


Figure (187) routing traffic sent in case number of nodes = 30 and number of nodes = 60 / Voice application/ nodes were posited circularly

Figure (188) Total number of quadrant changes in case number of nodes = 30 and number of nodes = 60 / Voice application /nodes were posited circularly

Figure (189) Total traffic received in case number of nodes = 30 and number of nodes = 60 / Voice application/ nodes were posited circularly

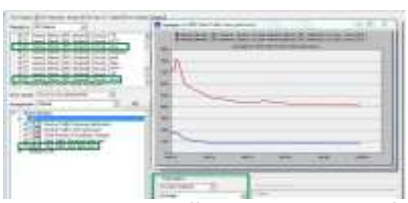


Figure (190) Total traffic sent in case number of nodes = 30 and number of nodes = 60 / nodes were posited circularly

Table (37) Comparison performance of geographical routing protocol in terms of wireless local area network (WLAN) standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for Voice application .

Voice Application							
Routing protocols	***Node placement***	***Number of Nodes***		***throughput***	***Delay***	***Load***	***retransmission attempts***
GRP	*circular*	***30***	***Aver.***	*237757.0663*	*0.001415862*	*61236.94079*	*1.28281748*
		60		*2348156.112*	*0.003798689*	*315152.6366*	*1.285489577*

Table (38) Comparison performance of geographical routing protocol in terms of GRP protocol standards in case number of nodes = 30 and number of nodes = 60 and nodes were posited circularly, but for Voice application

Voice Application								
Routing protocols	***Node placement***	***Number of Nodes***		***routing traffic received***	***routing traffic sent***	***Total number of quadrant changes***	***Total traffic received***	***Total traffic sent***
GRP	*circular*	***30***	***Aver.***	*369.9717493*	*94.51922261*	*1.563172144*	*369.9717493*	*94.51922261*
		60		*3526.013287*	*471.0980398*	*1.946573209*	*3526.013287*	*471.0980398*

We note from Tables (27), (29), (31), (33), (35), (37) that all WLAN standards (throughput, delay, load, retransmission attempts) in case number of nodes = 60 mobile nodes, much higher than their values, in case number of nodes was 30 mobile nodes for (Database, Video, Email, FTP, HTTP, Voice) applications, and nodes were posited circularly, as well as for GRP routing protocol standards (routing traffic received, routing traffic sent, Total number of quadrant changes, Total traffic received, Total traffic sent) where we note from tables (28), (30), (32), (34), (36)), (38) that all GRP routing protocol standards in case number of nodes = 60 mobile nodes were much higher than their values in case number of nodes was 30 nodes for applications (Database, Video, Email, FTP, HTTP, Voice) and nodes were posited circularly .

5 . CONCLUSION

In the first part of this article, performance of geographical routing protocol was evaluated in case nodes were posited circularly with different traffic loads (Database, Video Email, FTP, HTTP, Voice) respectively in a small network consists of 30 mobile nodes where network size was 1000x1000m in terms of wireless local area network (WLAN) standards and GRP routing protocol standards. As for the second part of the article, performance of geographical routing protocol was evaluated in case nodes were posited circularly with different traffic loads (Database, Video Email, FTP, HTTP, Voice) respectively in a large network consists of 60 mobile nodes where network size was also 1000x1000m in terms of WLAN standards and GRP routing protocol standards. As for the last and most important part, effect increasing number of nodes on performance of geographical routing protocol was studied and compared with different traffic loads in a large network and in a small network in case nodes were posited circularly in terms of wireless local area network (WLAN) standards and GRP protocol standards, where network size, whether network was large (number of nodes was large) or small, was 1000x1000m, as it was found that when number of nodes increased with geographic routing protocol, all wireless local area network (WLAN) standards and GRP routing protocol standards in case number of nodes = 60 mobile nodes was much higher than its values in case number of nodes was 30 nodes for applications (Database, Video, Email, FTP, HTTP, Voice) and nodes were posited circularly.

6. FUTURE WORKS

We can think in future by studying effect increasing number of nodes by comparing performance of more than one of routing protocols in mobile ad hoc networks, for example GRP geographical routing protocol that was studied in this article with DSR dynamic source routing protocol, in case circular node placement model for 30 mobile nodes and between their performance when increasing number of nodes in case circular node placement model as well,to becomes 60 mobile nodes with using the same network size with different traffic loads (Database, Video Email, FTP, HTTP, Voice) respectively in terms of WLAN standards and choosing the best protocol from among two protocols for each application depending on effect increasing number of nodes using OPNET 14.5 simulator.

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