QoS-based routing networks

Hamdollah ghamgin†, Fatemeh Shateri Aliabad††

†1Instructor, Department of Engineering, Payame Noor University, po Box 19395-3697,Tehran, IRAN
†† Department of ComputerEngineering,khalkhal Branch,Islamic azad university,khalkhal,iran

Summary
networks in recent years much attention have taken. This type of network users want to use the services of several Media are in these networks. This requires providing QoS for multimedia applications in networks is. Due to the nature of networks providing quality Service is faced with many challenges .In this paper, QoS-based routing is new .Algorithm The proposed clustering method uses a highly efficient and Development. These results show that the proposed method Other methods for reducing latency to improve end-to-end Packet delivery ratio has also increased

Key words:
Data network, QoS routing,clustering algorithm,. Disabled algorithms

Introduction

A network is a collection of mobile nodes without any The equipment of the infrastructure to communicate with each other. If Transmitter and receiver in the communication range can not be closed By intermediate nodes to the destination node.
The multimedia applications on these networks is highly regarded Is located. Support for multimedia applications requires a Efficient routing algorithms and mechanisms to ensure quality of service. From However, in networks due to unpredictable mobility nodes, Network topology is very variable and this makes it difficult to provide In this type of networks is the quality of service. The other challenges guaranteed quality of service in networks, lack of state information Accurate, common radio channel, limited resources and non-secure media is.
The inherent characteristics of networks makes the results Link state information such as delay, bandwidth, etc. Exactly Is not possible.
We present several routing algorithms for network That they can be in three categories: active, passive and hybridid.
Disabled algorithms (based on demand), when the path between two nodes It needs to be created to track 1 and 2. [This class of algorithms High initial delay, but less routing overhead.
Alternatively the active node routing algorithms with your information. Exchanged and thus before the route is needed, Caused [3 and 4. [Active algorithms overhead Update Information Links are very high, but there is no initial delay. Other problems These methods is their lack of scalability.
In combinatorial algorithms use a combination of active and passive methods and the benefits of the active and passive methods used. A sub-category of combinatorial algorithms, which are algorithms Clustering is used. In clustering nodes grouping and in each group as a parent node is selected. Node The leader of their group is in charge of operations. This algorithm is very Scalable and suitable to ensure quality of service.
In this paper, QoS-based routing algorithm using Clustering is provided. In the proposed method is to create clusters Clusters are created fast and very stable. Algorithm Proposed by simulation in the simulator NS2] 5 [the algorithm QOLSR compared. The simulation results can be concluded QOLSR that the proposed algorithm to delay end to end Lower and higher packet delivery ratio.

2-Previous works

In [6] a routing algorithm based on quality of service for networking Heterogeneous case is presented. The algorithm is based nodes their location in a series are permitted. Per The one or more nodes elected as leader. Selection the head based on the parameters of the battery nodes, nodes and speed the position of the nodes is done. Single parent nodes in operation Routing participate. Based routing algorithm used OSPF Method 1 And the parameters of delay and bandwidth to QoS routing have been considered. In this algorithm, A mechanism for calculating the delay and bandwidth are not provided. In addition, It is assumed that the nodes are informed of their location. This The use of the algorithm to specific nodes capable of understanding Their position limit.
In [7] node based on its available resources into three categories, nodes Quality of service, routing nodes and receiving nodes split be. Nodes by sending periodic messages HELLO, your profile Send to its neighbors. Each node receiving the HELLO message Its neighbor nodes can determine their category. In operation Quality of Service QoS routing nodes can only 1 to participate. AODV routing method for routing [1] Use And at the request of the requested bandwidth and latency states Be. In this algorithm because only the quality of service nodes Can participate in routing, routing overhead is low.

Manuscript received January 5, 2017
Manuscript revised January 20, 2017

In this way the interaction of neighboring nodes and consider its impact on bandwidth Not taken. In addition, it is intended broadband This is contrary to the inherent characteristics of networks.

The algorithm QOLSR] 8 and 9] proposed an algorithm based routing 2 quality service. This method is based on OLSR routing algorithm [3] is. In this way each node to the set of neighbors .

MPR series title Selects. During the broadcast packets 3 Control of a node, the node is the only node in the MPR series, Replay packets, and thus repeat playback messages Can be avoided. MPR each node to select a range, neighbors Through which they can select with all the neighbors of two nodes Jump away, communicate. In addition, this property try To be selected so that neighbors better service quality parameters Have (such as higher bandwidth and lower latency). Different methods.

QoS parameters to select and choose neighbors expressed is.

In the MPR set selection QOLSR need to exchange messages relatively Long. The number of these messages are also high. This leads to waste Thereby reducing the network bandwidth and network performance. Plus In this algorithm, nodes on a network are part of the structure and Routing can be done only through a series MPR. This makes It is always the best route is selected.

In algorithms more attention to choose the path with the most Bandwidth and lowest latency and stability parameters of the path less Is taken into consideration. Very variable network environment and this makes the available bandwidth and variable delay are. In this kind of network should be stable paths Selected to the impact of topology changes less frequently. In algorithm The proposed structure is proposed clustering makes clusters Network is stable. Given that the algorithm Proposed to be stable as parent node is selected And the parent nodes are selected based on address sustainability Paths created is very high.

3-Clustering algorithm

The main idea of this method using clustering for routing Quality assurance service. In this way we have tried to create processes and Cluster maintenance easier, faster and more efficient. The node selection The leader of the parameters used is more stable clusters To create a new cluster overhead is minimized and thus create Less clusters.

Each node can have four modes NORMAL, ISOLATED, And have CLUSTERED GATEWAY. Before all nodes in the cluster operations ISOLATED are. Each node periodically sends a message LIVE with its neighbors. LIVE message contains information that nodes that can weight categories To calculate. The head node is used to select division Be. Each node in the higher weight classes, and message LIVE Earlier to reach neighboring nodes, as leader Is selected. LIVE message structure is as follows:

LIVE (ID, IDch W, STATE)

ID calmer address each node. Parameter ID Is the parent node is a member or members of it. Early The amount of 1 -Ast. W Group node determines the amount of weight. Parameter STATE mode defines the node.

Nodes to determine their division, first determine your weight And then based on your weight and weight placed in one of three groups: Place.

(1) Weight = aN + bR + cT + dP

N parameter specifies the number of neighboring nodes. To calculate Neighbors, each node only those nodes as neighboring nodes Accounts that are not away from it. This by Czech power The signal from each neighboring node. Nodes, if a Node as the neighboring node adds to the list of your neighbors The signal strength received from them is not reduced. This makes To choose a closer neighbors, and thus be more realistic. By doing Other neighbors moment nodes as neighboring nodes will not be considered. The percentage of remaining battery R parameter per node. This parameter makes So that nodes can have a better chance of getting heads Have a longer life. The head of a cluster's life Extend the life of the cluster is created. And this is likely to create Again clusters is that it reduces costs. Parameter T Member In the last cluster node determines that its members. With Use this parameter to choose the leader, the more chance nodes To find that the parent latest stable, because the cluster That already have been longer membership. This will Choose a stable leader that leads to the creation of clusters Is stable. P parameter specifies power nodes. With Given these parameters more connected nodes that have power There is more chance of their head. As a result, the diameter of the clusters More will be created. Increasing the diameter of the clusters created Tdadanha reduction and the issue of providing network services Faster and reduces overhead.

Coefficients a, b, c and d are parameters determined by weight, based on System parameters can be specified. These parameters should be selected so That their sum is equal to one. Our ability to choose the coefficients This allows the proposed algorithm in networks with conditions Apply different.

Each node has a table in which information called NEIGHBOR Keeps its neighbors. Each node receiving the message LIVE from Neighbors, its data added to the table NEIGHBOR And your W parameter is recalculated.

In addition to the parent node has a table NEIGHBOR CHNEIGHBOR are also parent nodes where information Adjacent clusters to save it.

ISOLATED nodes after a certain time (Te (can start e choose their leader. If the node ISOLATED after time T The leader did not receive a message from a node in your

NEIGHBOR table The node is looking at weight classes above his own. If Node did not meet these requirements, as its elected leader And this is reflected in the next LIVE messages. If the node In his NEIGHBOR table node to be higher than its weight, the size of a Te time to do their work without the other parent Continues. This makes the other nodes conditions Leaders have a better chance to be given again. If The node after this time (2Te (message no parent node Does not get himself elected as head of state and his CLUSTERHEAD) Captain) changes.
Due to the low number of living groups (3 groups) and parent To be done quickly.
2Te of a node e if the node ISOLATED after time T Or LIVE messages received head node as its parent NORMAL mode to select and change parameters IDch with the node address set.
If a parent node of the message NORMAL , Can be converted to node GATEWAY. First parent node Searches related to their neighbors in the table and if the It did not Rapida, its data added to the table its neighbors and the GATEWAY their changes. Then, write a message NEW_CH new parent node information to its parent node Sends. The head node is the parent node information message NEW_CH CHNEIGHBOR adds new table.
NORMAL node of the cluster may be a node in the neighborhood Other clusters are NORMAL. In these circumstances because None of the nodes in the cluster head node transmission range NORMAL No other nodes GATEWAY can not be turned off and on As a result, there is no connection between the clusters. This issue None Clustering algorithm has not been previously considered. In algorithm Proposed, in this case both node-to-node message NEW_CH Head of his department, which sends information to the new parent node. As a result, communication between cluster is created.

4-Cluster maintenance

In order to maintain the established cluster, each node moderators intervals When Ti) Te >> Ti (alternately LIVE messages in your cluster he sends. Nodes of a cluster head node for messages The viability perceive it. NORMAL nodes and GATEWAY also need to send periodic messages present LIVE To announce further period of nodes with parent (2Ti. (If the members of a cluster head node i after time 2T Message received, conclude that the parent node is gone is. NORMAL mode and the nodes are nodes ISOLATED GATEWAY their modes occur. Or NORMAL mode The process (if you are a member of the cluster) or in case GATEWAY remain (if you have more than two cluster members). Because moving the nodes, the network topology varies. A node Every moment can not leave the cluster or a cluster join. Two The head can also be transmitted over the causes Each of them will interfere with the responsibility of leaders, This will impact on the services provided by the cluster. To avoid this effect, in this situation should be one of the leaders of Their leader step down. In most clustering algorithms out This operation is performed and one of the nodes goes to normal. From Disadvantages of this method is that changes in a parent makes sweeping changes Other group leaders and requires the majority of structures such as tables Routing re-establish that it is expensive. The Other members of the cluster nodes that have resigned Dvbah steps Register gone and this caused a delay in service Them.
In our proposed algorithm when two heads A and B in the period of transition Put together, one of them went to the NORMAL mode or modes GATEWAY goes. If Captain A, B receive a message from leader The first Czech to the state of all its members. If all GATEWAY members are in a state of their leader to step down NORMAL mode is determined and node B's head Selects as its parent node. But otherwise, in When members are not in a state GATEWAY, your division and Node B compares. If the parent B than in group Have a higher weight than the head and resigned GATEWAY goes mode.
If node A is aware that in the higher weight classes B is head to head B will send a message COVERLAP A. Captain B with a message COVERLAP perform the above operation Gives.

5-Routing

Routing based routing algorithm based on demand is. Each node has a routing table in which the routing information. Keeps his. Routing table includes fields: Node Destination next node, sequence number, spacing, minimum bandwidth Request, the maximum delay permitted, and credit flow path Is.
The URL of the destination node is the destination node address field. Address The next node determines the next node in the route to send the packet to Destination. Number field in order to avoid routing loops and repetitive posts are used. If you are routing messages that are processed into a knot that sequence number Messages from a specific destination larger than the sequence number in The routing table for the destination node. This simple act of sending repeated Routing packets prevented and also the looping write Navigation package to prevent. Field spacing, along the way Specifies. The minimum required bandwidth, the minimum width Gang current request specifies. This field is only about Currents Quality of Service (QoS flows that are required) Is required and will be processed only when the flow of Service quality is. In the field the maximum allowed delay, the maximum delay Quality of service is determined by flows tolerated. This At the time of write currents quality field service

applications. Kind Stream flow will be determined in the field. This field can amount Service quality or have the best effort. By the field type Service is a specific request. The field credit, time Specifies that a route is valid. After this time The path is not valid. If you receive a package of this field is kept Prior to the expiration time will be re-initialized.

QoS routing algorithm based on two Stage: Stage reservation and admission process. In the admission process The source node sends discovery requests your route. This request The maximum acceptable delay and minimum bandwidth is required. This Question during the broadcast leaders to reach the destination node. The intermediate parent node route request message, if the They can provide bandwidth on demand, request message through GATEWAY nodes to nodes in the neighborhood head Adjacent data and bandwidth reservations are requested. Bandwidth Is temporary and can be reserved the bandwidth nodes Definite lack the bandwidth required in the admission process Flows are best effort. But bandwidth nodes can not Reserved to the QoS flows others.

When the destination node receives the route request message, if Not demand more bandwidth and packet delay of the delay declarations Has been the source node responds. By sending a message from the destination node Step reservation and admission process starts over. Nodes Center received the message, the resources allocated resources reserved Change the mode of the day.

1-5Delay calculation

Delay calculation is done bilaterally. Member of the cluster nodes To calculate the delay on a link from the message LIVE use. Each Knot LIVE members receive packets from its parent node, by subtracting the time Send Knots of receiving it, the delay is calculated. This time The delay includes time waiting in line, time of transfer, time avoiding collisions and Time control is overhead. Each node of the delay calculated by Come on, it sends the message LIVE next to the parent node, The inserts. The head node LIVE members to receive messages, time Send the package is calculated and then between this time and time expressed Average LIVE conducted in the package and its routing table To occur. Each node can use the following formula to calculate delayIs:

2) delay $_{avg}$ =

$$\propto X\, delay_{avg}\,(t-1)+(i-\propto)X$$

$$measured-delay$$

(1-t (delayavg delay is calculated in the previous message.LIVE package specifies the amount of delay calculated delay_measured he does. α is a number between zero and one. The formula for Calculating a moment of delay to avoid the impact of changes in the network, The proportion of delay accounts in the previous period used to calculate delay Is. This leads to a more realistic calculation of the time delay.

2-5Calculating bandwidth

Calculating bandwidth available using standard MAC layer IEEE 11.802 in networks due to its being shared among Adjacent nodes is a major challenge. Based MAC protocols The CSMA all nodes that are within the transmitter interference, As long as the transmitter is sending data, able to write and Not receive the package. Interference radius around each node distance from node If that is the distance node packet sent by This node is decrypted and only can be felt. This is due to Interference caused.

Hence, the bandwidth available to a node, Tdakhlysh neighbors because the minimum bandwidth is not tied Tdakhlysh with the groups that are neighbors in the area and at the same time Disrupt them. Thus, each node in the use of bandwidth All neighbors Tdakhlysh subscribers. When calculating bandwidth This issuIn the proposed algorithm, each node of the cluster periodically available bandwidth And it calculates your LIVE messages sent to the head Sends her. The head node receiving messages LIVE Update the table its neighbors. The head node has received GATEWAY LIVE messages from nodes in its neighborhood, Bandwidth available for communication with adjacent nodes to the cluster head Calculate your CHNEIGHBOR table may also occur.e should be considered.

Each node bandwidth available using the following formula Is:

3) Available Bandwidth = (1-) *T

M The formula uses the link. This parameter is the length of time Indicates that the channel is occupied. Use the links of formula It is calculated as follows:

$$4)\ \mu = \frac{Busy\ Time}{Window\ Duration}$$

Busy Time parameter determines the time of transplantation. Parameter WindowsDuration specifies the total measurement time. T permittivity specifies that for a package the size of S bytes of The following formula is calculated:

$$5)\mathrm{T}=\frac{s}{t_q+(t_s+t_{CA}+t_{overhad})\times R+\sum_{r=1}^{R} B_t}$$

Tq parameter queuing waiting time at higher layers, t Its time erhead S-bit is closed, tCA time to avoid a collision, tov Time control overhead and Bt-time rollback.

3-5 The actual bandwidth available on the track

When routing bandwidth depends on the position of the nodes on track have. The nodes that are on a path interference in Are each other. For example, on a path length of at least 6 jump, nodes At least four knots in the middle of the track in an interference radius So when they send packets by the nodes, nodes The interference radius

do not allow them to send and receive packets. Therefore, The actual bandwidth available in the course of about a fifth of the bandwidth available is. To calculate the available bandwidth, each node of the following formula Uses:

$$6)\text{Real Available Bandwidh}=\frac{Available\ Bandwidth}{CSV}$$

CSN calmer based on the number of nodes in the presence of interference neighbors Are to be determined.

CKSN parameter setting is done with the following criteria: If the node is a neighbor of origin or destination, then 4 = CSN. If the node is the source or destination, then 3 = CSN. 5 = CSN is for other nodes. Using this formula QoS routing with a high degree of accuracy Is.

4-5 Route discovery

When a node wants to send a package, you must Perform route discovery process. Route

discovery process is as follows: Done :

If a node is in NORMAL mode package directions (RR (Sends to his head. If the node is in a state GATEWAY RR package sends to all Leaders in their neighborhood. Route request message includes fields: source address, destination address, number Thus, contour, maximum Takhyrmjaz, the minimum bandwidth required, during Life and is pending.

RR messages will be sent during the moderators. Each node receiving head RR message first if this package is not found previously in type Depending on the quality of service achieved a maximum delay delayed RR message can be compared. If the delay obtained more than The delay is mentioned in the package eliminates the RR message. Otherwise Then calculate the real bandwidth and bandwidth Compare the request. If you request more bandwidth The package is removed. Otherwise, Bandwidth on Demand Make a reservation, its routing table is present and close to Sends his neighboring heads. In addition, each node receiving the message RR If the address is not the origin of the message, an entry in the Its routing table information created and the path leading to the origin of the It imports.

Because it is possible to request a message be removed or another path Selected to send packets for each source booked a timer Regulated. If after the expiration of the time to answer any messages from Could not get destination node, the resources reserved are released. This leads Avoid wasting resources is a significant problem in networks,Is. Each node accepts the message, which it received RR Is not. Nodes using the number field and destination address Able to determine whether this package have previously received or not. RR when the message reached the destination node, perform the above procedure and The confirmation message (ARR (as to the source node sends. Nodes Upon receipt of the message ARR resources reserved for intermediate flow To allocate.

The source node receives the message ARR start sending messages. If the current type is best effort, intermediate nodes if Their paths to a destination by sending packets to Get the ARR origin, otherwise the package adjacent to the head. When the request message to reach the destination by sending ARP messages origin is aware of the way.

5-5 Keeping track

Path can be eliminated for two reasons: the loss of the next node On track to meet or lack of quality of service parameters. In the proposed path will be determined based on the head address.

Each node to the next node in the route in the routing table, address parent Next on the route. If while sending information, node GATEWAY Destroyed or out of communication range, if the parent node Another GATEWAY Nodules radio radius next leader On track and be able to meet the demands of its quality of service Uses. This makes the probability of route Less. If the node is the next head of the radius of foreign radio , The parent node of a closed path error (RE (create it The source node sends. Each node in the direction to get a message RE If necessary, update your routing table and the resources reserved It is free to flow. Source node to send a message RE All operations are stopped and found the path again.

Each node in the head repeatedly requested bandwidth and delay Czech is expressed. If the parent node determines that More than delay delay is mentioned in the message, to send the packet RE, the source informs. If the parent node determines that the bandwidth Less than the requested bandwidth is available, tries to remove Best-effort bandwidth request packets currents Provide. If there were no currents best effort or The resulting bandwidth is not enough, the parent node neighbors GATEWAY nodes are looking for that bandwidth on demand And with leaders meet next in line to be correlated. If so, Node found, it replaces the previous node, otherwise By sending packets RE, the source informs.

6- Simulation

In this section algorithm routing algorithm QOLSR Compared. Simulation software NS2 is done.

Nodes randomly in space with dimensions of 1000 * 1000 square meters They are scattered randomly moving. The maximum radius 300 meters intended use of the radio nodes. Of protocols 11.IEEE802 medium access control layer is used.

Traffic Source traffic type with a fixed rate by sending four 512-byte packets Seconds. Bandwidth each node s / Mb 2 is considered. In order to compare the two methods of delivery simulation parameters Packets and end-to-end average delay is used.

Package delivery percent: The percentage of packets arrive at their destination, The entire package is sent to the specified destination.
Average end-to-end delay: the average time specifies that It takes a packet from source to destination.
In Figure 1 percent packet delivery rate in the number of different nodes QOLSR proposed algorithm, and the algorithm is shown. With Increasing the number of nodes, the nodes interact with each other more and more likely As a result destroyed more packages and the shipping of Submissions will be reduced. There are 20 nodes when the delivery rate Unlike other cases closed lower. This is why in When 20 nodes in the network, the nodes because of lack of space Simulation, nodes are usually greater than the radius of their radio and As a result, it is possible to create a path less.
As is clear from Figure 1, packet delivery ratio method The proposed method is more QOLSR.

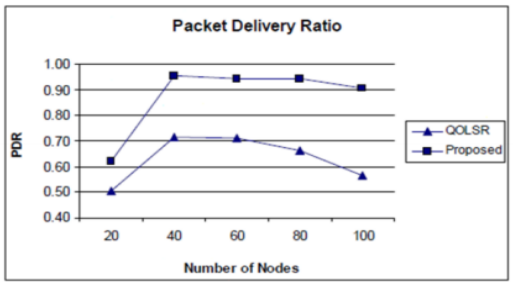

Figure1: percent packet delivery to the number of nodes.

n Figure 2, packet delivery ratio for the two algorithms in different states Move nodes is shown. In Figure 2 knots speed between 5 and 20 meters per second and up to 5 seconds nodes stops Are.
With the increased mobility of nodes, links and probability of loss As a result, packet delivery ratio decreases. In the proposed algorithm Local restoration due to the parent nodes when the Link loss, with increasing speed, packet delivery ratio less reduction have. As shown in Figure 2, the delivery rate algorithm The proposed algorithm is more QOLSR.

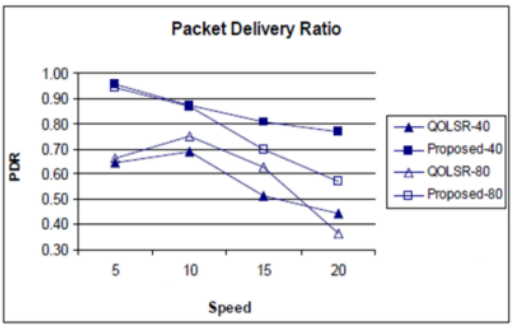

Figure2: Depending on the speed of delivery nodes.

In Figure 3 the current delivery rate depending on the number of nodes, For both algorithms have been studied. Currents of 30 percent, 60 And 90% of the total number of nodes is considered. with increasing Percent of currents, increased network traffic and thus the probability of Packages go further. In the proposed algorithm decrease QOLSR algorithm is less.

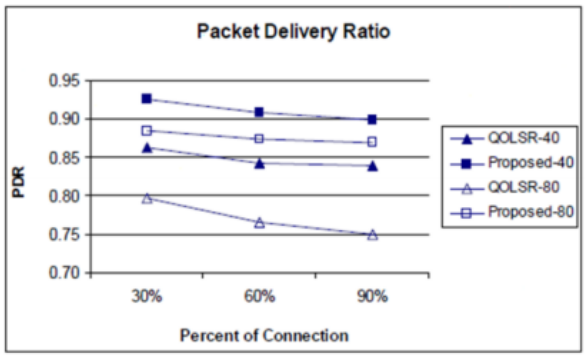

Figure 3: In contrast, the percent tage of packet delivery.

In Figure 4, the average delay between the end-to-end, while the number of nodes 20 to 100 nodes is variable for the algorithm shown is.

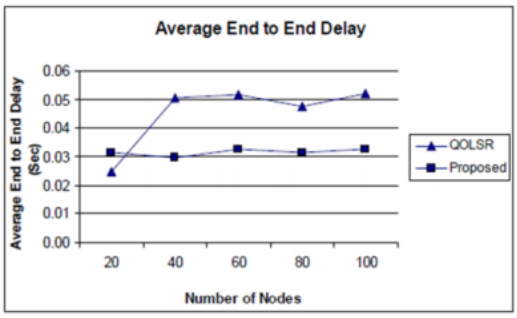

Figure4: The average delay versus the number of nodes.

In Figure 5, the average delay end to end for the two algorithms in the states Speed shown different nodes. In Figure 5 knots speed Between 5 to 20 meters per second and knots up to 5 seconds Stop.
With the increased mobility of nodes, links, and thus the probability of loss Packet delay is increased. In the proposed algorithm increases QOLSR method is less delay. In the proposed algorithm when The node on the path disappears, try to master nodes Replacing another node, the path to repair locally. a door Resulting in fewer lost packets and packages tolerate less delay they do.

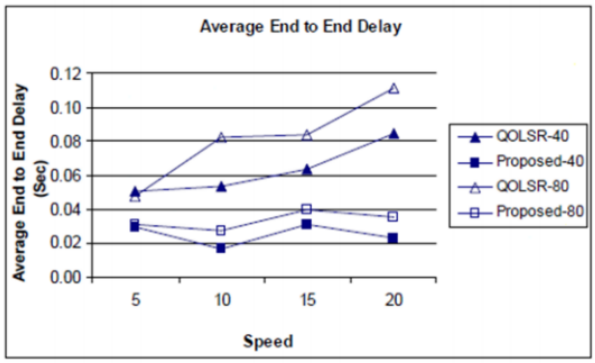

Figure 5: The average delay at the speed of nodes.

Figure 6 shows the effect of increasing the number of flows in the network for two algorithm Has been investigated. Currents of 30 percent, 60 percent and 90 Percent of the number of nodes is considered. As the number of streams, Increased network traffic and therefore more likely to interact nodes Is. This leads to further delay packets sent**.**

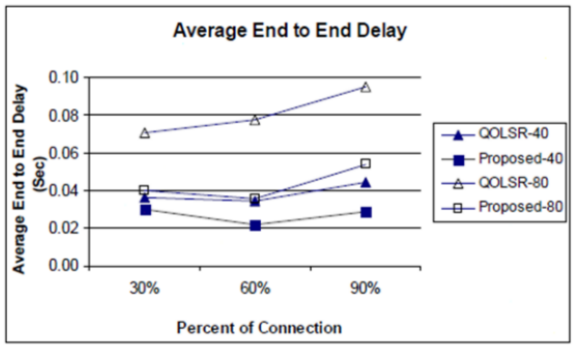

Figure 6: In contrast, the average delay percent

7. Conclusion

In a paper-based routing algorithm based on quality of service Clustering is provided. In the proposed algorithm tries to The most stable nodes to be selected as captain. The path The proposed algorithm is based on the address leaders. This leads To be more sustainable path for packets to be selected. Routes Makes more stable and increased the percentage of packet delivery As a result, end-to-end delay is less. In the proposed algorithm-based nodes to create a path quality The head node must perform the service demand. Node Only if the parent gives permission to create a new route The Group does not disrupt current paths. Thereby creating The path is controlled by moderators. The repair mechanisms in the proposed algorithm increases The packet delivery ratio. If the parent node detection The next node is gone that route can another node Used to send packets and track repair. This leads The need to create stronger relative to the path and closed lower again Reach their destination.

Reference

[1] Perkins C. E., Royer E. M., "Ad hoc On-demand Distance Vector Routing", Proceedings of the IEEE Workshop on Mobile Computing Systems and Applications, IEEE, 1999, pp. 90– 100.
[2] Johnson D., Maltz D., "Dynamic Source Routing in Ad Hoc Wireless Networks", Mobile Computing, Kluwer Academic, 1996, pp. 153-181.
[3] Clausen H., Hansen G., Christensen L., Behrmann G., "The Optimized Link State Routing Protocol, Evaluation Through Experiments and Simulation", Proceedings of IEEE Symposium on Wireless Personal Mobile Communications, IEEE, September 2001, pp. 841-846.
[4] Bellur B., Ogier R. G., "A Reliable, Efficient Topology Broadcast Protocol for Dynamic Networks", Proceedings of INFOCOM, 1999, pp. 178-186.
[5] Network Simulator 2, http://www.isi.edu/nsnam
[6] AL-Karaki J., Kamal A. E., "End-to-End support for statistical quality of service in heterogeneous mobile ad hoc networks", Computer Communication, 2005,pp. 2119-2132.
[7] Ivascu G. L., Pierre S., Quintero A., "Qos Support based on a Mobile Routing Backbone for Ad Hoc Wireless Networks", IWCMC, Canada, July 2006.
[8] Villanueva-Pena P. E., Kunz T., Dhakal P., "Extending Network Knowledge: Making OLSR a Quality of Service Conducive Protocol", IWCMC, Canada, July 2006.
[9] Munaretto A., Fonseca M., "Routing and quality of service support for mobile ad hoc networks", Computer Networks,2007