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# Modeling and Performance Analysis of Spiral Fishbone Network Using NS-2

**Pronab Biswas[1], Md Maruf Islam[1], Sayed Asaduzzaman[1*], Nazrul Islam[2], M. Raihan[3]**

[1]Department of Software Engineering, Daffodil International University, Dhaka, Bangladesh
[2]Department of Information and Communication Technology, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh
[3]Department of Computer Science and Engineering, North Western University, Khulna, Bangladesh
Email: *s.asaduzzaman.bd@ieee.org, *s.asaduzzaman@rmstu.edu.bd

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## Abstract

In this research, we have projected and carried out a novel fishbone network that shows better performance in the term of minimizing the packet delay with respect to sink speed. Previous study implies that sector angle affects greatly on designing fishbone network. Finite Set of nodes arranges to sense the physical condition of any system is called wireless sensor. Our designed fishbone network can be potentially applied for a wireless sensing system to formulate a whole network. The network is a novel design which has been finalized by comparing sector angle. Analysis takes place by varying packet delay according to sink speed. Future analysis takes place for Quality of Service (QoS) and Quality of Experience (QoE). Latency of Packet and its size is the measurement criteria of any network or service is called Quality of Service (QoS). On the other hand the user experience of using the designed network is called Quality of Experience (QoE). Our designed network has been analyzed in TCP Tracer to find out the latency or packet delay for different users. The user data has been shorted and equated among them for latency with different no of packets. Our proposed spiral fishbone network shows better QoS and QoE. In future more nodes can be added to design extended fishbone network for wireless.

## Keywords

Fishbone Network, Network Modelling, Performance Analysis, NS-2

## 1. Introduction

Over the last few years, it has been clearly seen that Wireless sensor network

(WSN) is improving comprehensively. Earlier, it was used in the small scale applications but nowadays it has become popular in various sectors, for example, argent medical responses, military superintendence, farming observation and sensor-data cloud application. Enlargement of remarkable computing along with communication characteristics in sensor motes has taken the system in the path [1]. Yet, establishing a new routing backbone which will give better results in every perspective is ultimately very challenging [2].

For simulating and analyzing the influential nature of any backbone or communication networks, Network Simulator 2 (NS-2) is used. NS-2 can produce both wired and wireless network functions and protocols. Having effective functionalities, NS-2 is being used tremendously in many sectors. It carries modules for countless network modules in particular, routing, transport layer protocol and application. Researchers can look over network behavior by using a simple scripting language to construct a network and can examine results that created by NS-2. NS-2 is not only one of the most used open source network simulator but also one of the most used network simulators [3]. There is another popular non-proprietary software named TCP-Trace. It is used for analyzing TCP dump files. [4] TCP dump is a computer program particularly, a data-network packet inspector that is executed within a command line environment. Its main work is to display those packets along with TCP/IP which is transferred or received within a particular network [5]. TCP Trace accepts packet-capture programs like tcpdumb, Wireshark and snoop as input files. TCP Trace may generate various sorts of output that carry information on every connection resembling elapsed time, bytes in addition to segments sent as well as received, retransmissions, round trip times (RTT), window advertisements and throughput. Not only that, different types of graphs can also be executed with it so that anyone can research further [4]. Quality of Service (QoS) is an important factor to any networking venture. It computes the all in all performance over any particular network. The parameters of QoS are packet loss, throughput, jitter, delay and bit rate [5]. Yet, a portion of those boundaries with the application itself (hence closer to the client) are more identified compared to the network activity, so client's observations for them are better associated. For example, previous examinations explored the connection between client's discernment and burst bundle misfortune (may be thought as an edge misfortune), jitter along with repelling. Hence, a detachment of studies, (e.g., convention suite in the internet) between network [6]. Quality of Service is especially significant for the vehicle of traffic with extraordinary prerequisites. Specifically, engineers have acquainted Voice over IP innovation with permit PC organizations to get as valuable as phone networks for sound discussions, just as supporting new applications with much stricter organization execution prerequisites [5]. Quality of Experience is a proportion of the general degree of consumer satisfaction with a seller. That means QoE is a step by which a seller can understand that the product of service that he is selling is customer friendly or not. It is often used in information technology (IT) and consumer electronics [7]. These days, QoE has picked up reputation in a scholarly exploration as well as corporate point of view. Schatz *et al.* said that under-remaining of the subjective execution, QoE should empower a higher extensive, better comprehensive of arranged correspondence frameworks and accordingly to supplement the conventional, more innovation can be driven in Quality of Service (QoS) viewpoint [8]. Another hot topic today is Mobile sink. Mobile sink reduces energy consumption of sensor nodes and avail decreasing data delivery delay within all nodes. It follows different types of mobility designs in the sensor plot, for example fixed path mobility and random mobility [9]. Starfish routing is a novel approach of creating routing backbone. The theory behind it is ring and radial-canals are placed in a specific form of actions because of every part of the source or main node of that particular backbone node can be accessible in a hope. The ring-canal works to help reducing the main point (hot-spot) difficulties. For better explanation of starfish routing, some figures have been attached bellow [1]. Within the paper we have introduced spiral routing, an angle based routing protocol. It is a novel model. We have worked with various types of angles to see the best result in terms of end to end delay and sink speed. We have collaged fishbone routing in right angle and made a modified fishbone routing. Expectedly, it gave the best performance than the previous works. From there we have got inspiration to work with right angles. As a result we proposed the spiral routing with right angle in its every connected node. We examine the model with NS-2 and TCP Trace and compared the result in MATLAB. After working with 44 users each time, we got our final result. Expectedly, we got the best performance in every step from our new routing model. Technologies are now running through Wireless Sensor Networks. It is now being used in agriculture, urban areas, Military sectors etc. Because of progression in advancements and decrease in size, sensors are getting associated with pretty much every field of life. Agriculture is one of such areas where sensors and their networks are effectively used to get various advantages. Choice of sensors and their powerful use to tackle agricultural space issues has been a burdensome undertaking for amateur clients because of inaccessibility of conglomerated data in literature. A research of Aqeel-ur-Rehman described the need of remote sensors in Agriculture, WSN technology and their applications in various parts of agriculture and reported existing framework structures in agriculture space. The study clearly has shown the use of WSN in agriculture [10].

Again, in military activities, there is consistently a danger of being assaulted by foes. In this way, the utilization of these modest sensor nodes will assist with lessening the misfortune. A study of Ishfaq Ahmad and others dissect the current writing of utilizing WSNs for military applications. They talked about the accessible situations of utilizing sensor nodes in the military employments. They plan to introduce a superior sending of sensor nodes for military purposes with the assistance of existing exploration work. They attempt to recognize various territories in which they can diminish the harm if there should arise an occurrence of aggressor's assault or adversary's flare-up utilizing a shrewd organization of nodes [11].

Md. Abdur Razzaque and Choong Seon Hong have misuse the measure of traffic load a node conveys to control its medium access recurrence by allocating the base dispute window esteem in a separated way. The proposed conspire is completely conveyed. The exhibition of the proposed plot is assessed by ns-2 recreations and the results show that it can fundamentally diminish the bundle misfortunes because of impacts and support drops, which thus makes a difference to upgrade occasion to-sink throughput. It additionally beats the current methodologies [12].

A paper by Md. Ahsan Habib and team present an overview of the existing conveyed portable sink directing conventions. So as to give an understanding to the justification and the worries of a portable sink steering convention, plan necessities and difficulties related with the issue of portable sink directing are resolved furthermore, clarified. An authoritative and point by point order is made furthermore, the conventions' points of interest and disadvantages are resolved as for their objective applications. They have introduced an extensive audit of the current appropriated versatile sink steering conventions. The special difficulties related with versatile sinks and the plan necessities of a portable sink directing convention are talked about in detail to give a knowledge into the inspirations also, the inborn components. A precise order of the conventions is given and the preferences and downsides of the conventions are separately decided concerning the execution necessities. The decided classes of conventions have various advantages which may give inspirations to new arrangements. The various leveled approaches abuse a virtual structure which serves as a meeting district for the sink ad and information bundles [13].

Ashok V. Sutagundar with Sunilkumar S. Manvi propose a multi-operator based homogeneous worldly information collection and steering plan dependent on fish bone structure of WSN hubs by utilizing a lot of static and versatile operators. The essential segments of fishbone structure are spine and ribs associated with the two sides of a spine. A spine associates a sink node and one of the sensor hubs on the limit of WSN through transitional sensor nodes. Their collection conspire works in the accompanying steps. They saw that their plan beats zonal based total plan [14].

In another paper Md. Ahsan Habib have created Starfish Routing convention, enlivened from water lymphatic arrangement in Starfish routing is, develops a steering spine accompanied by a focal ring waterway with a few outspread channels over the organization. The quantity of outspread trenches furthermore, the span of the ring channel have been together decided for a given organization to diminish the correspondence inertness from sources to the sink. The aftereffects of execution assessment outflank the cutting edge works regarding information conveyance deferral and organization lifetime [1].

Can Tunca and team proposed Ring Routing, a novel, appropriated, energy-proficient portable sink directing convention, appropriate for time-delicate applications, which plans to limit this overhead while protecting the benefits of portable sinks. Moreover, we assess the exhibition of Ring Routing through broad reproductions [15]. Existing routing models are fast but not at its best level. The quality of service is not that much satisfactory and Quality of Experience is also not good from the consumers end. The performances can be increased more but not all the previous researchers have talk about it. They intended to create novel routing model only but did not work to increase its performance. As a result, the research is not helping the mass people. They only worked at a fixed level.

One of the best paper about fishbone routing is by Md. Ahsan Habib, he along with his team gave a model named starfish routing. In that paper, they could work with angles. But they did not. The particular paper we are indicating, Starfish Routing is produced for Wireless Sensor Networks with versatile sink and water vascular model of Starfish. It constructs a steering spine powerfully relying upon guaranteed the nodes of network size along with transmission scope. The recreation outcome manifests the presentation enhancements in regard of information conveyance postponement and organization lifetime contrasted with the cutting edge works [1].

In another paper, researchers introduced a fish bone structure based information collection and directing in WSN utilizing multi-operator framework. Three degrees of collection are proposed: node level, ace (along spine of the fish bone structure) and neighborhood focuses (along rib of the fish bone structure). These collection nodes are chosen dependent on weight factor, Euclidean separation and lingering energy of sensor nodes. The proposed conspire utilizes static and versatile operators to frame a fish bone structure beginning from sink hub to the last node along the reference pivot (spine) chose by sink node. Afterward, it chooses the neighborhood and ace collection nodes that suits for the information collection utilizing versatile operators and performs information collection along the fish bone structure starting from last node in spine up to sink node. When contrasted with the zonal based total plan, proposed conspire performs better regarding total energy, accumulation time, and conglomeration proportion. A portion of things to come works that can be considered for the proposed plot are as per the following: sink node as versatile, limiting segregated hubs, different reference tomahawks and spines, sensor node versatility and heterogeneous information collection. Investigation of our plan may likewise be stretched out by framing a few subareas in an organization region also, permitting various fish bones in various ways from the sink node with limitation on number of nodes on the rib [14].

Another paper proposed a novel versatile sink steering convention, Ring Routing, by both considering the benefits and the downsides of the current conventions in the writing. Ring Routing is a various leveled steering convention dependent on a virtual ring structure which is intended to be effectively open and effectively reconfigurable. The plan prerequisite of our convention is to alleviate the foreseen hotspot issue saw in the progressive directing methodologies and limit the information announcing delays thinking about the different portability boundaries of the versatile sink. The exhibition of Ring Routing is assessed broadly by recreations directed in the OPNET modeler condition. A wide scope of various situation with changing organization sizes and sink speed esteems are characterized and utilized [15]. Performance analysis of Dynamic web server has been analyzed in [16] where JSP and PHP have been used. We have found so many scopes to work with by which a new routing model can be come out with best performances.

## 2. Research Methodology

1) Introduction

The previous works we have studied, we found some scopes by which we can work further. All the researchers applied new and different ideas to find the best performances. But no one has examined with angles to the nodes if that can give better result or not. So, we have tried to apply different types of angles.

2) Equation and Theory

In the cutting edge research, speculative models are created for breaking down typical start to finish postpone where just jump separation between the root to the versatile sink is of thought of. Regardless, in light of intrinsic nature of remote immensely changes not simply on the jump separation yet also on the amount of re delivery end eavored at every expectation. Around there, a chain based like Markov theoretical model for start to finish postponement of bundle is created considering each of the above boundaries.

A Markov model is a Stochastic method for randomly changing systems. Here present states do not depend on past states. These models show all possible states as well as the transitions, rate of transitions and probabilities between them. Markov models are often used to model the probabilities of different states and the rates of transitions among them. The method is generally used to model systems.

Here, evaluating the anticipated number of dispatch and re dispatch attempts for a packet at each hop given bellow, [1]

$$\overline{z} = \sum_{z=0}^{k} z \rho_H^z \tag{1}$$

The simulation tests acted in NS-2 to change speeds of the portable sink. Accelerating of the versatile sink in the framework. Typical beginning to end pack delay for speculative and multiplication results over steering spines lessens in light of diminished ordinary skip division. Regardless, More deferral requires when sink speed is high, achieved by extended after an ideal opportunity for restriction of versatile sink with the participation of backbone. The proliferation values are viable with the theoretical examinations.

Normal throughput is assessed with the amount of data bytes successfully got by the sink in the term of time. Most worth addresses better execution. Normal start to finish bundle conveyance is the typical time contrast within the package gathering time at the sink and parcel age time at root. Lower regard shows latest execution.

Bundle conveyance proportion is the extent of the amount of got parcels at the sink to the created packages by the source hubs. The high the esteem the better the execution.

Standard deviation ($\eta$) of extra energy is the typical energy levels on spine $hubs\,(z)$ and can be resolved as follows, [2]

$$\eta = \sqrt{\frac{1}{|z|}\sum_{z=1}^{|z|}\left(E_{res}\left(z\right)-\mu\right)^2} \tag{2}$$

where, $E_{res}(z)$ says the hub's extra energy and the 4 indicates outstanding energy of all spine the scattering of the essentialness uses among the spine sensors. The $\eta$ regard is depended upon to be little explanation it shows better limit of the Starfish Routing spine so that the change energy can be used. Organization Lifetime is resolved from the sending of the organization to the time at which sink gets distant from a bit of the framework. Technical overhead is assessed extent of supreme control bytes exchanged within the whole reenactment time to the total of data bytes passed on to the sink. Somewhat worth exhibits improved execution.

3) NS-2 Installation

We have used NS-2 for our simulation. At first we installed it. The installation process is given bellow. **Figure 1** shows the step by step installation and configuration process of NS-2 Software.

4) Best Angle

At first have designed three different types of angle, Finer angle, Right angle and Obtuse angle in NSg-2 and simulated them with the same value in NS-2. From the simulation, we have found three different results. We plotted the result in MATLAB and saw the comparison graph. The graph gave us the result following. **Figure 2** shows the different angle simulation of the networking model. We have chosen 3 different angles to optimize the best angle. Actually in geometry there are three angles mainly formed.

From the graph in **Figure 3**, the red line indicates right angle, blue line indicates the right angle and the red line indicates the obtuse angle. So from the above scenario, it can be seen that the packet delivery delay of right angle is the least among all other angles according to the sink speed (packet/seconds). The packet delivery delay of finer and obtuse angle start from 1.06 ms and ends at respectively 1.19 ms and 1.21 ms. Whereas right angle's packet delivery delay started from 1.02 ms and ended at 1.06 ms. It is not even closer to the other two. So we can say that the delivery delay of right angle is the lowest. As a result we understand right angle is the fastest among all types here. So, as we thought that the angles can be an issue for better performance, it comes true for us.

So our first finding is, right angle can give the best result in the term of packet delivery delay and sink speed (packet/seconds).

```
Step 1: Download NS2
           Download NS2 from below mention link:
           https://sourceforge.net/projects/nsna...
     1.1 Create the New folder with the name "NS2" in Home and
     1.2 Paste the downloaded file "ns-allinone-2.35.tar.gz" in the same folder

Step 2: Update and install prerequisites packages.
     2.1. Now we have to update the Ubuntu with its latest components. Open up a terminal
          and run these commands:
          sudo apt update
   2.2. Before installing the NS, we have to install some essential packages required by the
        NS. So, run the following commands:
         sudo apt install build-essential autoconf automake libxmu-dev
         sudo apt install gcc-4.8 g++-4.8

Step 3: Extract and Install NS2
        3.1. tar zxvf ns-allinone-2.35.tar.gz
        3.2. . /install

       if you have ERROR like:
       make: *** [mdart/mdart_adp.o] Error 1
       Ns make failed!
Now to Solve this ERROR, make below Mention changes in Makefile.in and ls.h

Changes in Makefile.in:
After extracting the "ns-allinone-2.35" folder, open up the file "/ns-allinone-2.35/ns-
2.35/Makefile.in" in an editor.  You can do it either from the terminal or from the file explorer
(Nautilus).

Changes: CC = @CC@
             CPP= @CXX@
Replace to
            CC = gcc-4.8
            CPP= g++-4.8

Changes in ls.h
            open the file "/ns-allinone-2.35/ns-2.35/linkstate/ls.h" in an editor. Once you have
opened the file move to the line 137 and replace the "erase" with this– erase and save the file.

Now to install NS2:

3.3. Open up a terminal and run these commands:/install
--------------------------------
Step 4: Open bashrc file to set the Environment Variables
      4.1. Open the bashrc from the Home and Add the following lines in the file.  Be sure to
change "/path_to" to the path of where you have extracted the NS (e.g. '/home/user_name/Documents').

export PATH=$PATH:/home/ubuntu/NS2/ns-allinone-2.35/bin:/home/ubuntu/NS2/ns-allinone-
2.35/tcl8.5.10/unix:/home/ubuntu/NS2/ns-allinone-2.35/tk8.5.10/unix

export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/home/ubuntu/NS2/ns-allinone-2.35/otcl-
1.14:/home/ubuntu/NS2/ns-allinone-2.35/lib

NOTE: You may want to create a backup of the .bashrc before editing, the easiest way is to copy the
file to a different location. Later you can replace the edited .bashrc with the copied one in case
something goes sideways or if you want to remove the NS.

Step 5: Validate the Installation
You need to validate NS to check if everything is OK but keep in mind that it will
take a lot of time (about 1:30 hrs). Open up a terminal and move to the directory
'/home/user_name/Documents/ns-allinone-2.35/ns-2.35/' and run:
./validate
------------------------
```

**Figure 1.** NS-2 Installation with configuration.

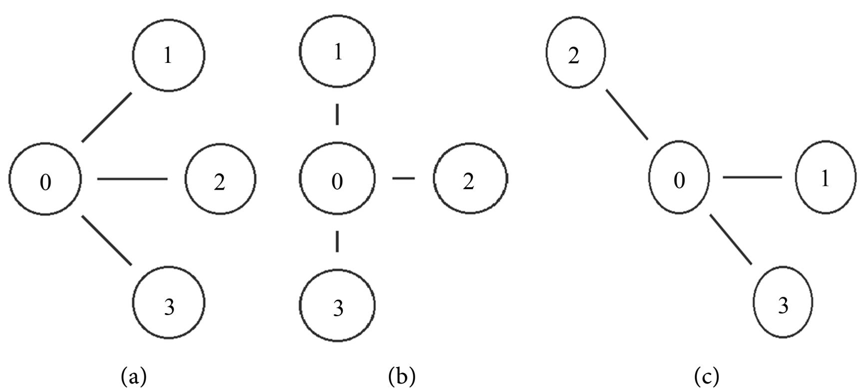



**Figure 2.** Different angles simulation in NS-2 (a) Finer Angle; (b) Right Angle; (c) Obtuse Angle.

**Figure 4** defines three different routing model. Where 4(a) is existing routing model called as fishbone, 4(b) is randomly created model with the same nodes as others. And 4(c) is also a fishbone model but the node is constructed in 90 degree angle. We created the models in NS-2, also simulated them individually in NS-2 as well. Then we collected data from the NS-2 output. And show the results in MATLAB. The result of the graph made with MATLAB is given bellow. The range of each data is same.

In the graph shown in **Figure 5**, we can show three different lines. Red color line resembles the model hepta, the model we have created randomly. The blue color line resembles the existing fishbone model and the green one is our modified fishbone model in right angle. The result of the graphs is taken according to packet delivery delay with sink speed (packet/seconds). From the graph, we can see that the red line or the hepta model takes the most delay in packet delivery and its sink speed (packet/seconds) is also very low. Whereas the other two models give better result than the first one. Though the existing model of fishbone gives an impressive result, but the best performance considering the following

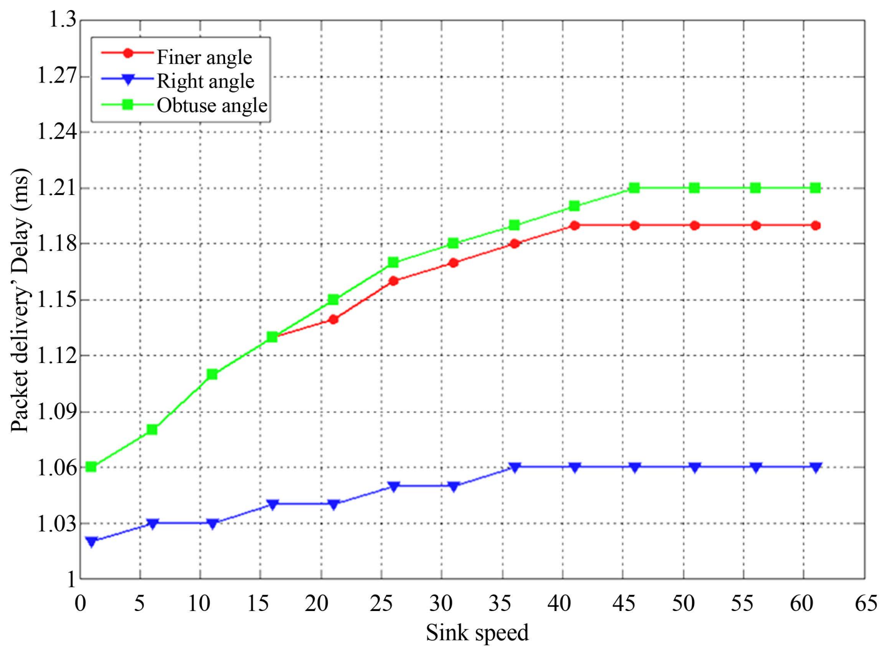



**Figure 3.** Graph of the simulating results in NS-2 of Different angles.

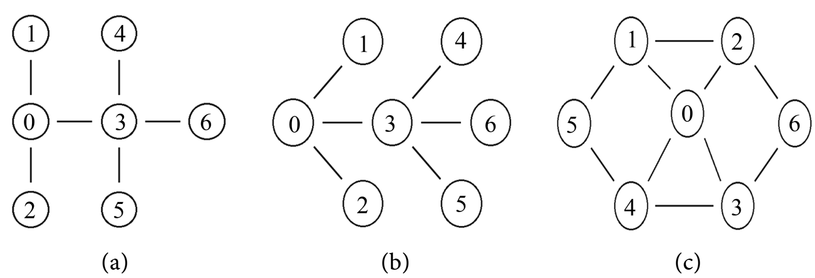



**Figure 4.** Models to find best result of fishbone (a) Modified Fishbone; (b) Fishbone; (c) Heptagonal Model.

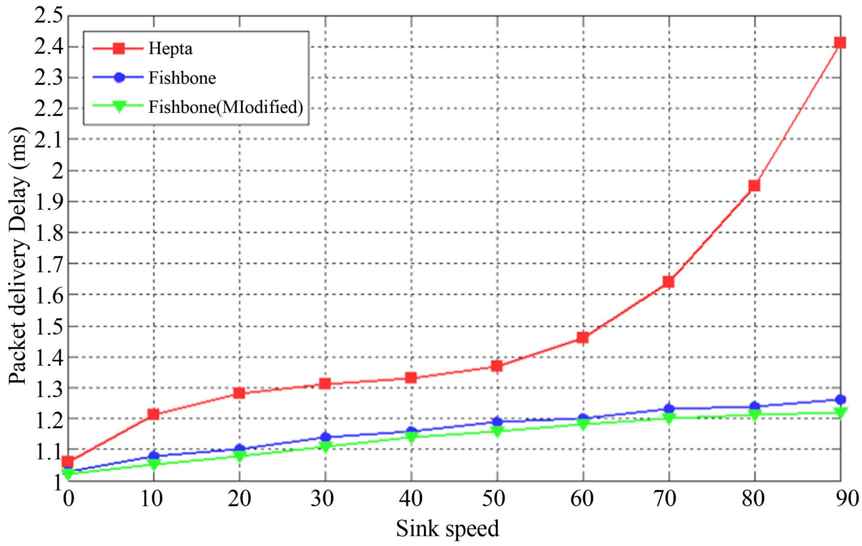



**Figure 5.** Graph of the comparison of fishbone.

models is given by our modified fishbone model. The model shows the lowest delay according to sink speed (packet/seconds).

So we can say that the angle can really give the best performance. We come with the decision that if we can use the angle in any other routing model that can also give us improved result than the existing models.

This method and the findings of our work have given a huge turn over by which we tried to propose a novel routing model.

## 3. Results and Discussion

Firstly, we built some models with generating different types of angles. We saw the differences within the angles and found that 90 degree gives the best result among the angles. Unfortunately no one has worked with in this particular way before. They concentrated in other portions of the model and applied many rules but not thought about angles can change the performance as well. After finding the value of angle which was 90 degree, we got an idea to reconstruct the existing fishbone routing model with 90 degree. The idea comes out because the existing model has about 60 degree distances from node to node. We made the distance at 90 degree and simulated in Network Simulator-2 or NS2. After finding the output, we compared with the output of existing fishbone in the term of Packet Delivery Delay and Sink Speed (packet/seconds). The comparison made with MATLAB so that we can visualize and easily compare them. Surprisingly, we found that our new fishbone model gives the better result than the previous one. Then we tried to invent a new model rather than reconstructing the old one. We applied the method of angles and combine 10 nodes with them this time. The model looked like a spiral so we named the new model as spiral model. We compared the results of spiral model with the existing routing models this time the comparison is also took place in the term of Packet Delivery Delay and Sink Speed. The graph (**Figure 6**) shows that, our new model is way better than the

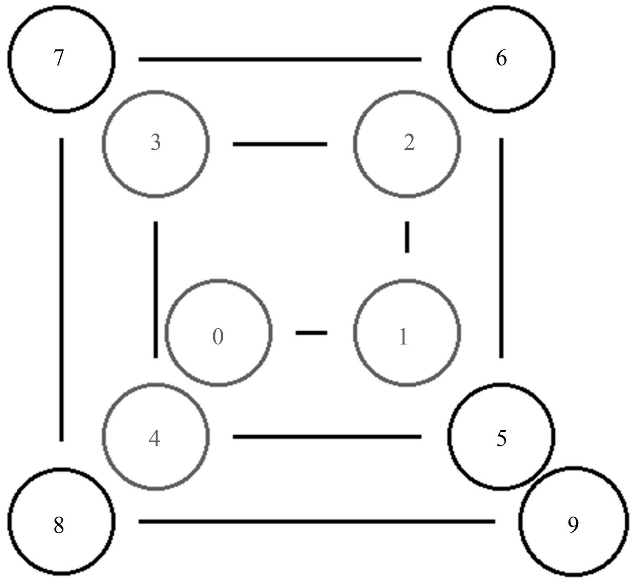



**Figure 6.** Spiral model (novel model).

previous models. Because it takes the lowest packet delivery delay in compared to sink speed. Best performance will be valueless if users cannot use it. So for user experiences, we took 42 users in TCP Trace and sent different number of packets. Our research has not been completed yet. We wanted to propose a novel routing model which can give better result than the previous models. We applied the methodology what we found from our research. We tried to build so many types of routing models. At last we built a model which is purely new model and a novel idea. We applied our 90 degree angle method there and we named the novel model as spiral model. The model created in NSg-2 is given bellow.

Figure 6 shows the new type of model named spiral model. It looks like a spiral with the angles of the nodes are all 90 degree. We have taken more nodes than the previous to see the result. All the models we had worked before were total 7 nodes, whereas our novel model has 10 nodes. We thought, if we can get better result in much more nodes that means that can sent more data within a short period of time. We have simulated the model in NS-2 to see the result. The data we got from the simulation were examined with the previous data. The visual graph is following. The result we can see from the graph that our proposed model (Spiral) gives the best result though it has more nodes. For more, we have run the file in TCP Trace. We have taken 42 individual users and we sent three different packet sizes. We compare the users with RTT (Round Trip Time) and Packet Size each time. Some of the selected data from TCP Trace is given bellow that we used for our research.

Figure 7 depicts that comparison of graph models. The graph shows that spiral model shows that the proposed model (spiral) has lower packet delivery delay. Lower packet delivery delay is a good result in terms of networking performance.

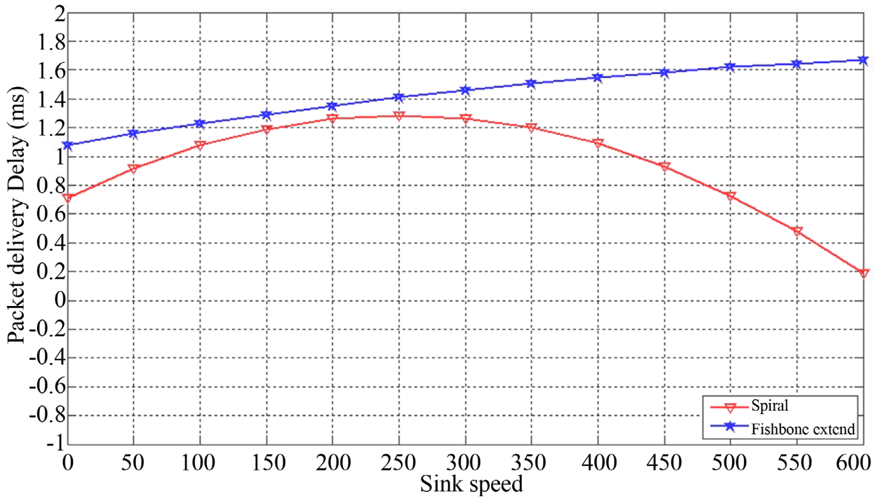
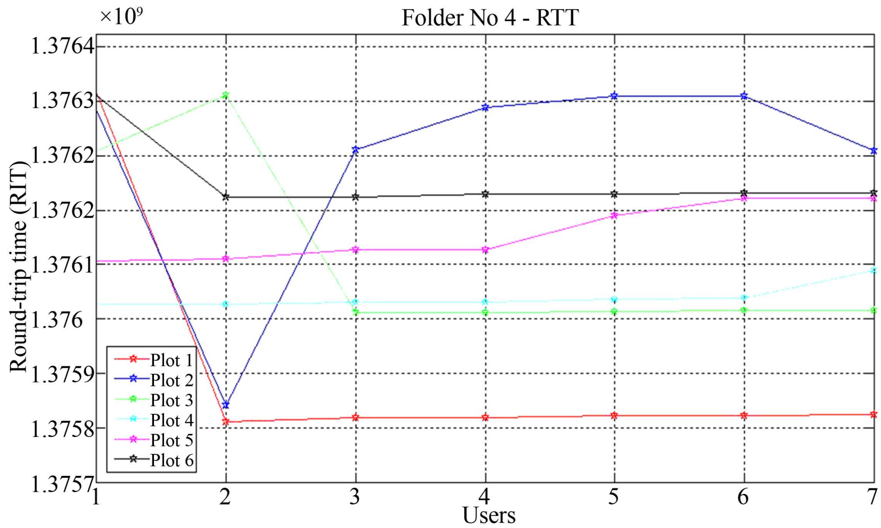



**Figure 7.** Comparison graph of all models.

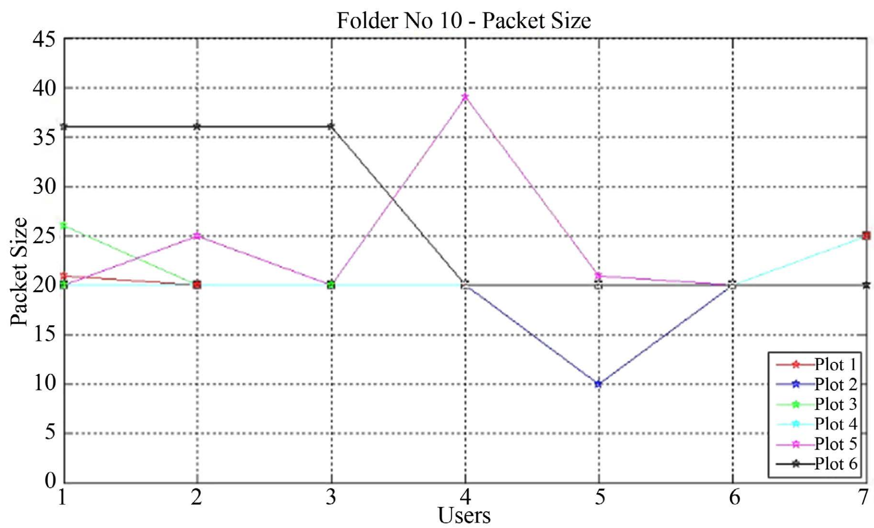
In **Figures 8(a)-(f)** shows the different round trip time for different users. Here we have considered 4, 10 and 16 users. We also compared the output and saw them visually in graphs. We made two types of graphs for each packet size. We saw the comparison with users in RTT and Packet size respectively. We divided the 42 user into 6 sides where 7 users get placed in every side. As a result we finally got our desired routing model which is Spiral model. The model is associated with angles and it is faster than the previous ones. This is a novel model proposed by us. Not only is that, our findings and reconstruction of fishbone routing with 90 degree angle also a novel model. Both models perform well compared to the models we have discussed in the paper. The packet delivery delay is less here. Our comparison in TCP Trace also shows a result that also indicates that our proposed model will also be user friendly. That means QoE of the users will be good as well.

## 4. Conclusions

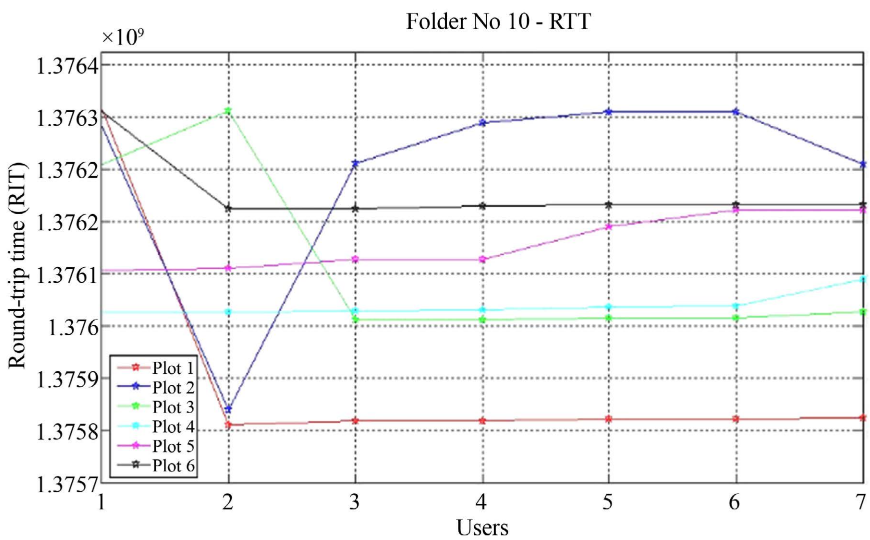
We analyzed the performances of the existing models and tried to improve them. At last, we have completed doing our research with some extraordinary results. We learn about QoS along with QoE and applied in our models so that the user experience may come better from the previous. Another thing is that, taking random data from NS-2 or TCP Trace is easy but you have to focus and always be accurate while taking data, because you have to go through some mathematical terms so that you take the selected data from the random. We gave much concentration in this part. For formatting each and every data, we applied the same rules everywhere so that the results may not be changed because of the data collection. We have chosen a selective amount of data from the outputs of NS-2 and TCP Trace. Our routing models have been created with NSg-2 and we simulated the model in NS-2. We created so many types of models and execute them to find the best result. Our first work was to see the performance of the existing models. While we find one routing model with the best performance, we started to


Folder No 4 - RTT
×10⁹
1.3764
1.3763
1.3762
1.3762
1.3761
1.376
1.3759
1.3758
1.3757
Round-trip time (RTT)
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Plot 6
1
2
3
4
5
6
7
Users

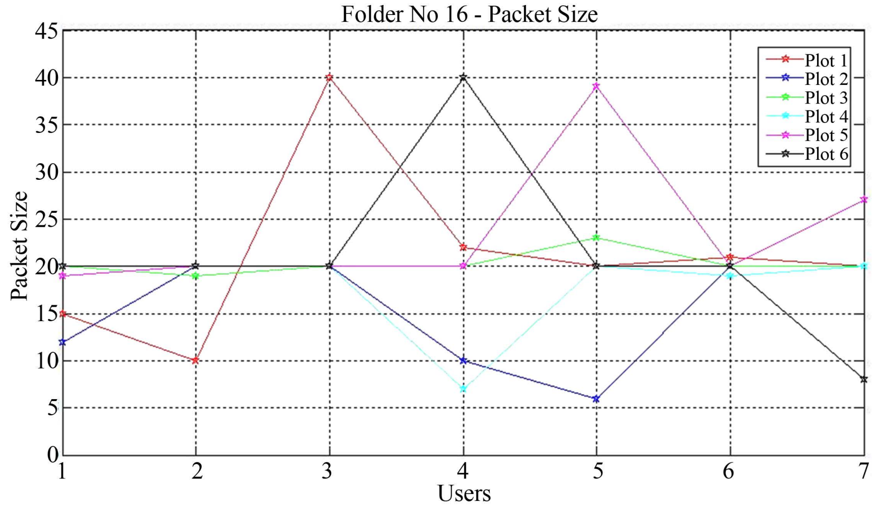
(a)


Folder No 10 - Packet Size
45
40
35
30
25
20
15
10
5
0
Packet Size
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Plot 6
1
2
3
4
5
6
7
Users

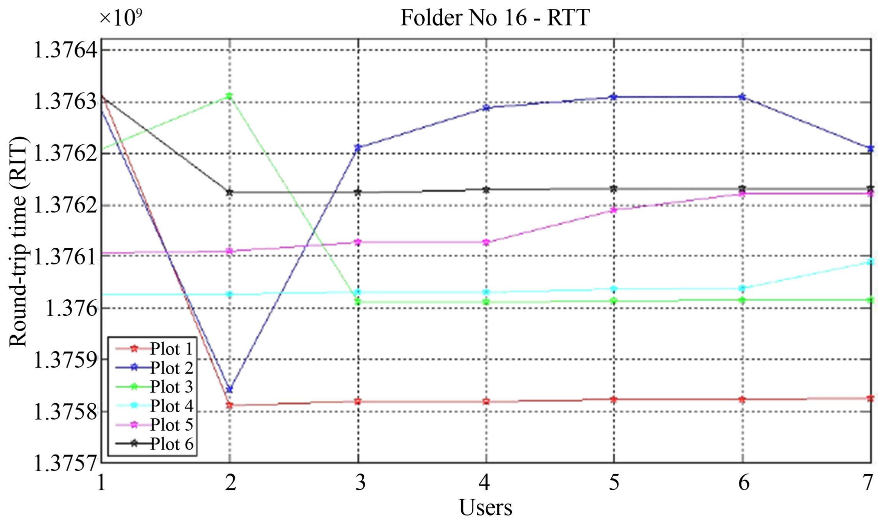
(b)


Folder No 10 - RTT
×10⁹
1.3764
1.3763
1.3762
1.3762
1.3761
1.376
1.3759
1.3758
1.3757
Round-trip time (RIT)
Plot 1
Plot 2
Plot 3
Plot 4
Plot 5
Plot 6
1
2
3
4
5
6
7
Users

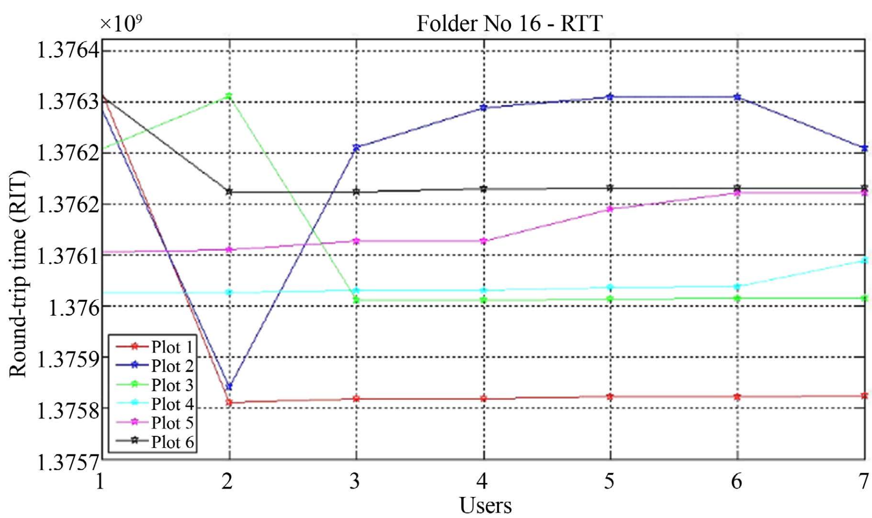
(c)




(d)




(e)




(f)

**Figure 8.** (a), (b), (c), (d), (e), (f) Different RTT for different no of users.

work with it. After studying each and every part and method of that particular model, we found something new to work with. The model's performance was good but we wanted the best one if possible. The previous study showed us there was some lacking. The researchers once talked about angles but never used them. We got the point and started to work in that part, we sent 4, 10 and 16 packets so that we can see the difference in the performance. But we found a good result this time also. So we think the user experience will be good and better than the previous models. So, in this paper, we researched and found that 90 degree angle to nodes can give the best value. We have reconstructed a new fishbone model which also gives the better result. We proposed a novel model called spiral model and showed why this model is better.

## 5. Future Works

The researchers who want to work further, can work in the following sectors. We have worked with angles and got the value. There may be some other method which can give better performance than ours. Researchers can work with the spiral model and research to improve its performance. They also can propose another model by applying our methods. Our work was limited to one liner data transmission. Others can work with multi step data transmission as well as they can use loops. The comparison made by us was with NS-2, there are so many simulation tools which may vary the result. This can be another research scope. We just worked with 42 users and three types of data packets. So anyone can evaluate the performance with applying more users and packets. The evaluation of ours was limited within Packet Delivery Delay and RTT. So new researchers can evaluate in other ways as well.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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