An Implementation of Adaptive Multipath Routing Algorithm for congestion control

N.Krishna Chaitanya

Research Scholar, ECE Department, JNTUCE, KAKINADA

S.Varadarajan

Professor, ECE Department, S V University College of Engineering TIRUPATI

Abstract
This paper proposes a better adaptive multi path routing technique for routing the data packets effectively from source to destination under congestion at a router. In traditional adaptive multi path routing techniques, if congestion occurred at a router then the route is changed from source to destination. In a single path routing algorithm, all the data packets transmitted through a single path, where the time taken to transmit the packets is more. This drawback is eliminated by using multi path routing technique, where the packets are transmitted through different paths. The proposed method provides a better solution for minimizing the congestion by rerouting the data packets over other paths, which are not utilized by the same in multi-path routing. This method avoids the unnecessary dropping of packets at a congested router and improves the network performance.
Keywords
Congestion, multi-path routing, Packets, router

1. Introduction

Most of the routing techniques in a network are based on a single path. As the number of data packets transferring increases, the data traffic increases in the network, as a result congestion will occur. To avoid this, multi-path routing [5] is preferred. In multi-path routing, the total available data is split and transferred among several paths.
Many multi-path routing protocol techniques have been proposed in networks. Some of the multi path routing techniques are Simultaneous Multi Path Communication (SMPC) [1], and Distribution and Congestion Minimized Multipath (DCMM) routing [2]. The existing methods are used to reduce the congestion in multipath routing.
In multi-path routing, still there is possibility of occurrence of congestion. This paper proposes a method to avoid the congestion occurring in multipath routing. It reduces the unnecessary retransmissions and delay for data packets, which will affect the performance of the network. In order to avoid congestion, multi path routing along with load balancing is used [3, 4].
The rest of the paper organized as follows. Section 2 provides the overview on the existing multipath routing techniques. In Section 3, we introduce the proposed Adaptive Multipath Routing for Congestion Control (AMR-CC). The Section 4 discusses the flow chart used in this method. Section 5 presents the simulation results, and section 6 concludes the paper.

2. Existing Methods

One of the multipath routing techniques is Simultaneous Multi-Path Communication [3]. There are two types of SMPC's available; they are (i) SMPC-I & (ii) SMPC-P. Here both the techniques are based on bandwidth control.
In SPMC-I [1], all paths for communication are treated equally. The bandwidths of each path are controlled independently. In this technique, it is possible to control the bandwidth for each path with no information of any other path.
In SMPC-P [1], the priority will be given to the paths that are used for data transfer. If the total communication bandwidth used for data transfer is greater than the available bandwidth, it uses priority control scheme. In this, the communication bandwidth is controlled by decreasing the bandwidth of one of the paths in ascending order of priority level among the paths having a lower priority.
In these methods, still there exists a problem because of reducing the transmission bandwidth in the network, which will increase the data transmission delay and reduces the network performance.
Another existing method is Distribution and Congestion Minimized Multipath (DCMM) routing. Here, in this method, the routing decisions minimize network congestion, routing decisions address link congestion avoidance topology and maximum flow optimization. Here, number of paths in multi path routing is reduced, and as a result, it is unable to minimize the congestion [5].
Because of the limitations in the available techniques, a new technique has been proposed to minimize the network congestion and to improve network performance.

3. Proposed Method

A method was proposed with an algorithm, flow chart and presented by Chaitanya, N. Krishna, S. Varadarajan, and P.

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Sreenivasulu[6]. In this method the drawbacks in existing methods of multipath routing are eliminated. In this, Adaptive Multipath Routing for Congestion Control (AMR-CC), multiple paths are chosen and the load is distributed among the paths. Here, all the paths may not have the same capacity and capability. However, the load is equally distributed, because of the insufficient resources at a router in a path, but there is a possibility of congestion at that router. This can be minimized by this method. If congestion occurred at a router then it verifies the status of its neighbours. If any one of the neighbours is available as free then the congested router forwards the data packets to that router. This will be able to avoid the unnecessary retransmissions from the sender and reduces the overall transmission delay of data packets. As a result, the performance of the network increases. The delay to transfer the packet from source to destination depends on message size, transmission speed, link propagation delay, per hop processing delay and number of hops. General formula for total delay calculation based on the above parameters is indicated as

$$Total\ delay = Propagation\ time + transmission\ time + Processing\ time + store\ and\ forward\ time$$

Let us consider a network with N nodes that are connected by L links. This situation is indicated as

N = {n1, n2, n3…}

L = {l1, l2, l3…}

Based on these, a number of paths are chosen from source to destination in order to transfer the data packets. By using distance vector routing algorithm, a number of paths are calculated. These are paths are arranged on delay. The paths are

P = {p1, p2, p3…}

Where, p1 < p2 < p3…

The major problem with the single path (pk) routing is, finding the single path from sender to destination by reducing the total network congestion. This is also going to affect the links of selected route. To overcome this problem multipath routing is preferred. In this method, all the paths are well utilized; as a result, its performance also increases. But the drawback is, if any node or link fails, then the data is lost and is retransmitted by sender. To avoid this data lost and retransmission, here proposing an algorithm for re-routing of data packets through its neighbours under link or router failure cases in order to avoid the congestion in the path. Alternate path is chosen through its neighbour by sending a request. If a neighbour accepts the request, then the packets are routed it are routed it. Thereby, reducing unnecessary discarding and retransmissions.

Algorithm for the proposed method is

Algorithm

Step1: finding the best paths from source to destination
P = {p1, p2, p3…pi}, where 1< i < n
Step2: Sort all the paths based on their performance metric delay.
Step3: Now choose a subset of paths from P
P’ ⊆ P
Step4: Distribute the load based on traffic in the network.
Step5: if congestion occurs
request (neighbours j)
Step6: if request ‘accepted’
re-route the data through the path.
Step7: calculate the delay
Step8: evaluate its performance

4. Simulation Results and Discussions

Proposed algorithm is simulated by using NS-2 with version ns-2.35. Simulation results are compared for single path, multi path without congestion control, multipath with congestion control and adaptive multipath with congestion control. The proposed method works quite well and its performance is compared with all other techniques. For simulation we considered the following topology.

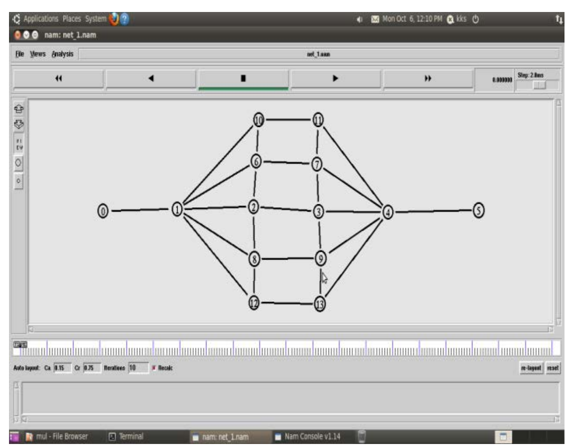

Figure 1: Example topology taken for simulation

From figure1, number of routers between source to destination are 12. Assuming that all the channels have the same capacity and all the routers has the same capacity.

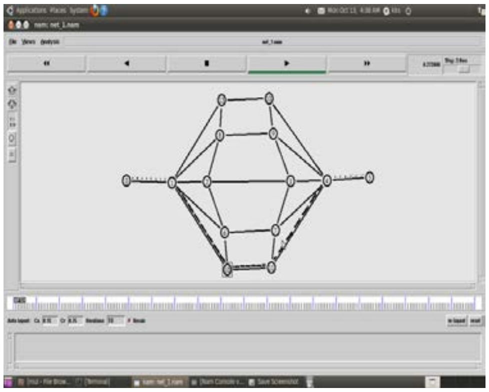

Figure 2: Single path packets transfer

First we analyzed the packet transmission through single path, where the time required to transfer the data is more. It is a basic method for routing of packets, but it is the least preferred method nowadays.

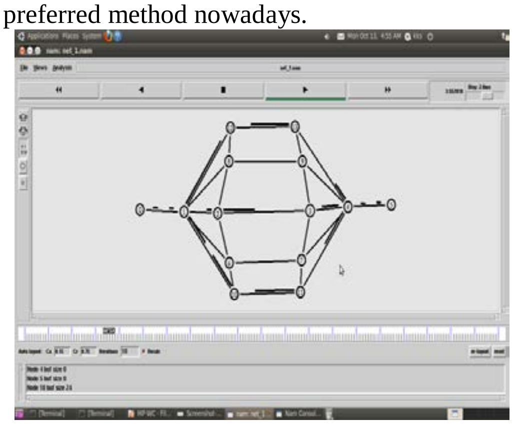

Figure 3: Multipath routing without congestion control

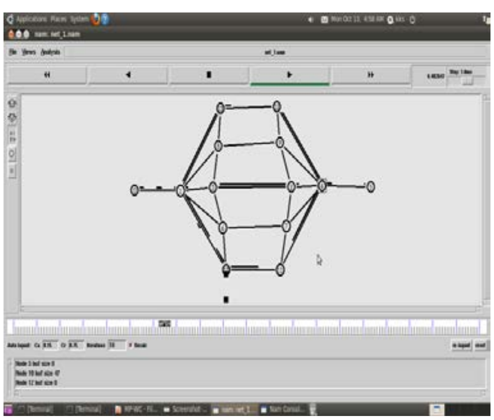

Figure 4: Packets dropping at a congested router in multipath routing with congestion control

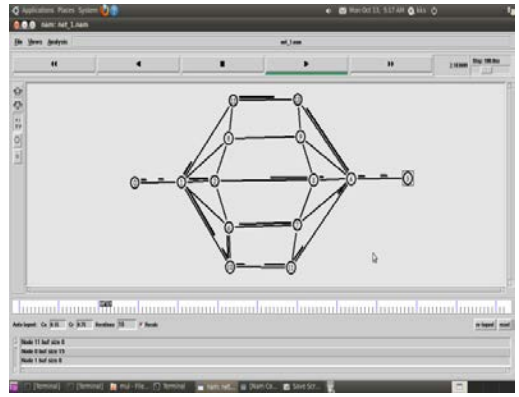

Figure5: Proposed method

Table 1: Comparison of packet transmission techniques

Technique	packets sent	packets received	packets drop	packet delivery fraction (%)	average end-end delay (s)
Single path	**1000**	**891**	**109**	**89.1**	**1.09**
Multi path without congestion	**1000**	**1000**	**0**	**100**	**0.75**
Multi path with congestion	**1000**	**931**	**69**	**93.1**	**1.01**
Proposed method	**1000**	**1000**	**0**	**100**	**0.159**

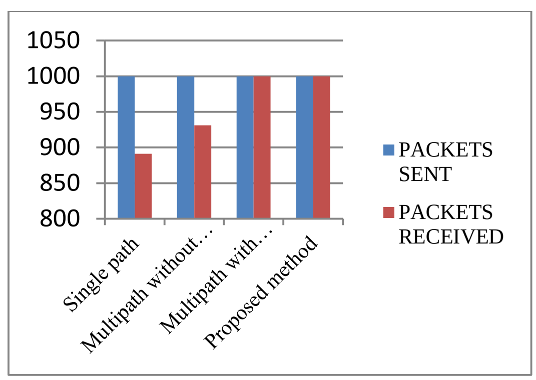

Figure 6: Packets sent versus packets received

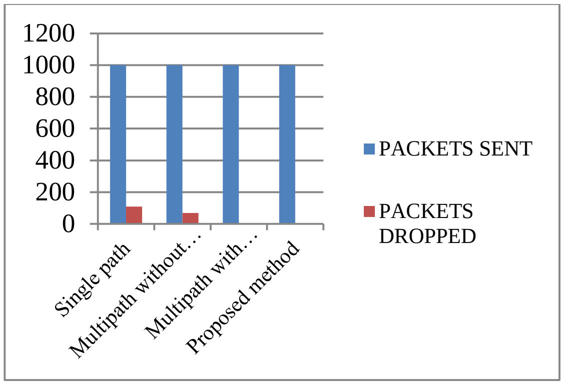

Figure 7: Packets sent versus packets dropped

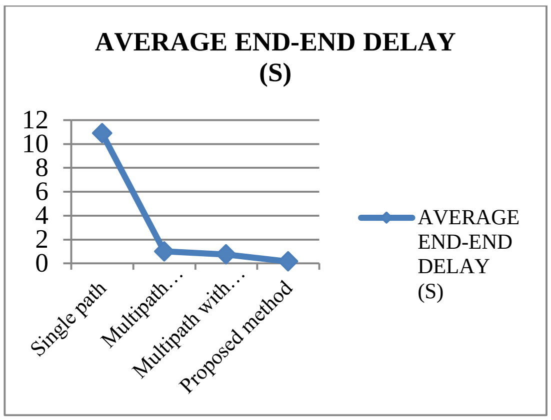

Figure 8: comparison of average end to end delay for various techniques

It is very clear from the diagram that the proposed method performs well compared to the existing methods in basic multi path routing techniques. As the table1 shows the number of packets sent and received for various methods are compared. In our proposed method, number of packets dropped is zero. In addition, the delay for transferring the packets in case of congestion is reduced because of adaptive multipath routing.

5. Conclusions

In this paper, we simulated and verified packet delays, packet delivery rates by using NS-2. Simulation results are observed for different methods such as single path data transfer, multipath data transmission with and without congestion control. From the results we analyzed that the delay is deceased and the packet delivery rate is increased compared with traditional routing techniques. This method is preferred to achieve more packet delivery rate and reduced delay.

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