International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Throughput and Packet Error Rate Analysis Using Routing Algorithm

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Abstract: ***In now a day's explosion of digital world results in faster, easily accessible, most efficient, reliable communication over the network communication to exchange the information. Considering this advantages, this paper introduced the network on which shortest path algorithm implemented to communicate some nodes on network in shortest, efficient path with efficient throughput mechanism. The nodes carry the data in the form of packets which consists packet header with IP addresses of source and destination and data payload with user information. In the simulation, it estimates the throughput, arrival and blocking rate with packet error rate by implementing ARQ protocol with cooperative diversity system.***

Keywords: Wireless Network, ARQ Protocol, Shortest Path Algorithm, Throughput Analysis, PER

1. Introduction

The peoples are communicates from several centuries, in several ways with several things at any time for exchanging their ideas and information this process is nothing but communication. The technology helps to provide efficient ways for faster, efficient, and reliable communication. Among of these ways the fixed telephone network, broadcasting in television, radio, computer networks like internet are beyond it. The digital, computer, wireless communication are considered , highest speed, low cost, very efficient, and most reliable communication are highlighted. Computer network is usually defined as collection of computers interconnected for gathering processing and distributing information. The computers, laptop, mobile phones are considered as node which generate a network. In communication network the medium between them may be wired or wireless for example if wired then they are connected via cables, wires or in wireless medium may be space, air , radio waves.. For the propagation of voice call over the internet, local area network, metropolitan network world wide network or mobile network it essential to forward the call fast, without blocking, without waiting time, congestion or with minimum traffic load. When the call is generate the data payload and also the controlling information is merged in the forms of packets, and then send over in network.

The ARQ (Automatic Request Repeat) protocol is implemented here to terminate errors in packet transmission. Thus, it enhances reliability of transmission via packet retransmission in communication link. It is facilities ARQ transmitter and receiver which transmits and receives packets with acknowledgement. When data not reached to destination negative acknowledge (NACK) message is send to transmitter and then that specific packet is retransmitted. For cooperative diversity system an Automatic repeat-request (ARQ) protocols employing Almouti space-time coding is investigated in this thesis. The mainly pre- cooperating and post co-operating protocol are two types of ARQ protocols are introduced and analyzed here which depending on different feedback schedules in a propagated frame at the target. These protocols help to enhance the throughput in co-operative system and indirectly of designed network, can also helps to provide basic tools which are useful in designing most complicated ARQ protocols.

When packet are transmitting or retransmitting there is need to be choose smaller, more efficient path in network so the concept of routing is introduced in this proposed work. Routing is the process of propagating the data from source to target node over the network at minimum weight [5], [6]. In this paper the weight includes minimum as well as efficient reliable total distance, network throughput, availability between desired source and destination. In various layers of system network layer includes routing algorithm to find optimum and reliable network. This optimum route should get changes with source and destination change, this paper include random i.e. changing source and destination. So we have to calculate its throughput in the form of network performance, optimal distance, and traffic load in each time. Thus routing algorithm provides the advantages as, simplicity, accuracy, stability, optimality, robustness. When the networks randomness increases, topology changes, scalability increases robustness and stability start affecting [6] [9]. Thus in this paper the routing algorithm are introduce to improve network's routing performance. Dijkstra routing algorithm is one algorithm which very efficient, reliable, faster algorithm. In this algorithm the vertex (N) i.e. node and edges (E) are links main components [3]. This algorithm uses the weight with positive value only. As the number of nodes increased in terms of hundreds the results degrade in terms of stability and speed [6].

When the packets are reached their relevant destination the various parameters are calculated and traced over the graph. This analysis is mainly done on parameter such as throughput, delay, call blocking rate, bit error rate. Thus the overall calculation and analysis give better estimation, better calculations results using routing algorithms.

2. ARQ Protocol

In this paper, an ARQ protocol implemented to maintain higher link reliability for co-operative diversity system. The number of antenna used at receiver and transmitter are compact the effect of fading occurs in wireless communication system. Since implementing number of antennas at mobile station is impractical, because of its limited size of mobile unit. In most of wireless application recently there s new form of diversity introduced that is co-operative diversity to getting single antenna diversity.

Co-operative diversity consist broadcast nature and generate a virtual antenna array in wireless communication through co-operative users, that's why all user are play role of transmission in communication [1]. This results in higher throughput and decreased channel variation sensitivity. There are different strategies consider in relaying such as amplify and forward which is generally for source node to relay node which amplifying signal and then forward to destination. Secondly is decode and forward here source decode the information and direct transmit it to destination [5]. The third one is compress and forward where source sent into to relay node then compress it without decoding sent it to destination node by relay node.

In this paper we use the combination space time two user cooperative diversity systems with ARQ protocols. The co-operative ARQ protocol studied in two aspects one is past cooperative ARQ protocol, where after entire packet frame is transmitted then ACK and NACK message are sent to users, second is pre co-operative system which is completely based on almouti based cooperating procedure, here destination check as received data in two non co-operating sub frame and then co-operative subframe [1], [5], [8].

In high user destination average received SNR at the destination, the past cooperating protocol achieves low improvement than pre cooperative protocol, where in pre co-operative protocol optimized 50% gain in user throughput as compare to post co-operative protocol[1]. After a whole co-operative frame received then destination feedback, the CRC result of received packets which is combination of multiple. ARQ process and two user co-operative system. It is classified in three cases of packet error.

1. Case (I) [There is no any error]
   In this case the source get message that their packets which is transmitted are absolutely correct in complete feedback duration. Then system ready to start for next co-operative system.

2. Case (II) [Only one of the user's packet is corrupted]
   When one of user consist error, destination drop that packet and send two messages in feedback duration for correct packet and erroneous packet respectively. Then there is retransmission done for user who sends erroneous packet. While to the other one user destination send next packet in that frame.

3. Case (III) [When both user's send erroneous packet]
   In this case destination drop packets from both of the user and send them NACK message for retransmitting that packets. When after one retransmission there is again erroneous packet found then destination discard that packet and causes an error event.

In pre co-operative ARQ only the ACK or NACK feedback is anterior to co-operative phase to improve ARQ efficiency. If the direct transmission possible then there is no need to co-operative process.

3. Shortest Path Algorithm:

The network is form with the number of nodes connected with each other via a medium. The source node, target node and intermediate nodes are mainly required for forming network. Source node is a starting node which information transfer to destination and the target node is the node that receives all information when communication completes. The connectivity provides the various paths for source node to destination. This path differs from each other because of its weight. The weight may be consist network throughput, distance between the source and destination, traffic. According to weight the path is decided to route on the network and sends the data from source destination this process is called routing [6].

There are various algorithms available in routing out of them the most probably used routing algorithm that is Dijkstra's algorithm implemented in this proposed work. . In 1956, Edsger. W. Dijkstra, Dutch computer scientist invented Dijkstra algorithm and it is published in 1959[7]. The Dijkstra's algorithm is simple shortest path algorithm in the minimum cost path is calculated where the path is made up of connecting two nodes in network via a link or edges. This algorithm specially designed for graph which consists of single source channel and non-negative edge weight. This algorithm finds the distance from the source to the other node for shortest path, by finding the distance between each and every node distances with source node [4]. In second way it is only find the distance from single source node to single and specific destination node, and when required destination is find it get stop not further proceed for all remain existing node in the network. The Dijkstra algorithm runs with O ($|V|^2$) where V is number of vertices in the graph. The steps for Dijkstra's algorithm are as follows

The main procedure to implement algorithm is start with labeling method. Initial node, current node, temporary node, destination node, visited and unvisited nodes are labeled for nodes. In this process firstly we have to consider tentative distance value which temporary distance calculated from current node.

1. Firstly source node from where routing procedure started is set as initial node which also known as starting node and where routing get stop is set to be destination node.
2. Assign tentative distance from source or initial node to value 0 and tentative distance from all other nodes to value ∞ which are the initial tentative distance value.

3. Form the set of unvisited node i.e. unvisited set by making all nodes are set to be unvisited node. The only current node set to initial node.
4. Now start from current node, the all neighbouring node from current node are unvisited nodes then find the tentative distances from it. If current tentative distance is less than the previous recorded distance then overwrite that distance as temporary distance.
5. Now mark that node as visited node and removed it from unvisited node set so visited node never checked again. Go to all neighbouring node and make it as visited by considering it as current node
6. Check whether given current visited node is destination node or if the smallest tentative distance is ∞ then we stop and make it as permanent node. Thus the algorithm gets finished.
7. If not select the unvisited node which consisting smallest tentative distance and make it as next current node and go back to 4 th step and further repeat process until and unless destination node is not visit.

4. Performance Analysis and Simulation

The performance parameter calculated here on the basis of throughput and SNR also packet error rate also find here. These parameters are explained in detail as follow. This system mainly based on packet-by-packet model so its analysis based on packet-error-analysis.

Throughput Analysis

The throughput is defined as it's a ratio of number of information bits in Packets which are correctly transmitted by total duration required for it to reach destination [1].

$$T = \sum_{i} {}^{I}/_{t(Ai)}\, P(Ai) \qquad (1)$$

The above formula used to calculate throughput T where, the information bits in a packet is I, the total duration time is t(Ai) and A is indicates all probability event which transmit correctly to destination. The P (Ai) is the probability of Ai.

PER (Packet Error Rate):

According to Rayleigh fading channel the average packet error rate (PER) with respect to average received signal to noise ratio (SNR) $\overline{\gamma_{ij}}$ is given as follow[1][12],

$$\overline{PER}_{ij} = \int_{0}^{+\infty} PER(\gamma_{ij}) f(\gamma_{ij}) d\gamma_{ij} \qquad (2)$$

$$= \int_{\gamma_{ij}}^{+\infty} \frac{a_n}{\bar{\gamma}_{ij}} exp(-b_n\gamma_{ij} - \frac{\gamma_{ij}}{\bar{\gamma}_{ij}}) d\gamma_{ij} + \int_{0}^{\gamma_{pn}} \frac{1}{\bar{\gamma}_{ij}} exp\left(-\frac{\gamma_{ij}}{\bar{\gamma}_{ij}}\right) d\gamma_{ij}$$

$$= 1 - ex\,p\left(-\frac{\gamma_{pn}}{\bar{\gamma}_{ij}}\right) + \frac{a_n}{1 + b_n\bar{\gamma}_{ij}} exp(-\left(b_n + \frac{1}{\bar{\gamma}_{ij}}\right)\gamma_{pn})$$

Where, the approximation of instantaneous PER is indicate as PER(γ_{ij}) [12]. The other parameters likes γ_{pn}, a_n, b_n depends on modulation, packet length and other factors. The value of it is provided by [12]. The simulation is done at transmission mode as an uncoded BPSK modulation system. The software used here is network simulator 2 i.e. NS2 which provide better methods for handling retransmission of packets.

5. Result

The results are in the form of graphical presentation which is plot the graph throughput Vs Average SNR and PER Vs. SNR. The simulation runs on UNIX (or LINUX) platform due to its flexibility and modular nature. It is a simply event driven simulator. The figure (1) represents the graph of throughput vs. Average SNR which is evaluated by above formula of throughput.

The figure (2) represents the Packet error rate in percentage by using above formula of PER versus SNR in decibel. The value for plotting graph given by table which gives evaluated values of SNR and PER.

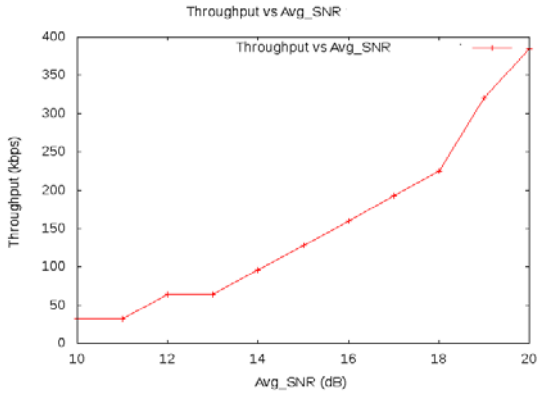

Figure 1: Throughput evaluated in kbps verses average SNR in dB

Table 1: Value of SNR and PER

SNR in dB	PER in %
15	26.08
15.68	24.86
16	22.7
17	21.3
17.16	21.2
18.19	21.06
19	20.52
19.54	18.9
19.91	18.78
20	17.76

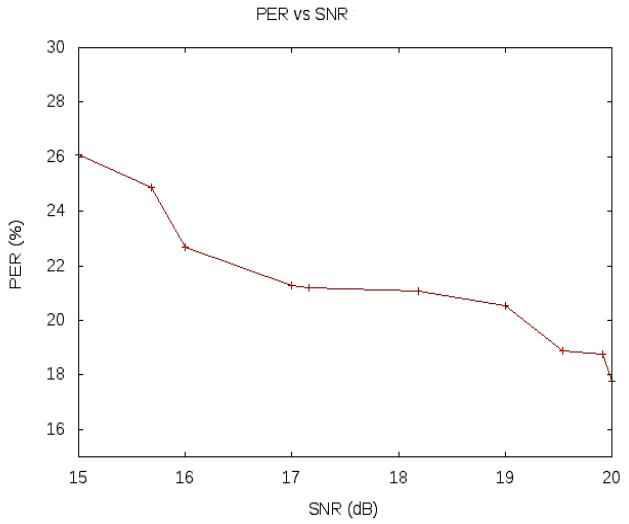

Figure 2: Packet Error Rate in verses SNR in decibel

6. Conclusion

In this paper, we proposed ARQ protocol with shortest path algorithm on the network. The ARQ protocol uses then it increases the retry limits with that link reliability is also get increased. It results in to enhancing the throughput which represents number of efficiently received packets per seconds. ARQ protocol run with shortest path algorithm helps to improves SNR minimising packet error rate. The simulation executed over NS2 software gives more reliable, flexible performance on LINUX platform. The shortest path algorithm (SPA) gives well determined path and scales better with larger number of nodes for larger network in high speed.

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