INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 1)
Available online at www.ijariit.com

Improving End-to-End Throughput in Wireless Network Using Spatial Reusability

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ABSTRACT

The optimal route from the source node to the destination node that guarantees a high end-to-end throughput is the main issue of routing in multi-hop wireless network. As the environment is heterogeneous the issue seems to be much complex, most of the solutions end with local optimum because those algorithms mostly fail to ensure an end to end throughput. By considering spatial reusability of wireless media, the end-to-end throughput in wireless multi-hop remote systems can be enhanced massively. To support the argument, Spatial-reusability Aware Single-path Routing (SASR) algorithm is proposed and compared with existing single path routing protocol. The assessment showed that proposed protocol show significant improvement in end-to-end throughput in comparison with existing protocols.

Keywords: *Wireless Network, Spatial Reusability, Routing.*

1. INTRODUCTION

Because of the constrained limit of wireless communication media, and lossy wireless connection [16], it is imperative to a great degree to choose a path that augments the end-to-end throughput, particularly in multi-hop wireless network. A principle issue with existing wireless routing protocol is that limiting the number of transmissions to convey a single packet from source node to destination node does not rely on augmenting the end-to-end throughput [4].

This paper examines routing protocol in single path routing. The goal of single path routing is to choose a cost-limiting path along which the packets are conveyed from the source node to destination node. A large portion of existing protocols links quality aware routing. They just select the path that limits the overall transmission count or transmission time for transmitting the packet.
An important property of wireless communication media which differentiate it from wired communication media is the spatial reusability. Wireless signal loses its energy through each hop [2]. Therefore, two links can be used at same time, if they in the far distance. But existing protocols do not take this into consideration.

2. RELATED WORK

In this area, a quick review of related work is done. And also compare our work with these and briefly review other works that consider reusability.

There is various work on wireless routing metrics. For single path routing a few link equality aware measurements [1][6][7][9] are proposed. RTT [1] measured the cost of the single wireless link by the round trip delay of probe packets. ETX [6] allocated the link cost with its normal number of transmission to effectively convey a packet. Based on ETX the author in [9] outlined ETOP metric considering the connection genuine position on the way.

The early single path routing protocols [3] [10] [17] [18] applied Dijikstra's algorithm for selecting a route. Some current cross-layer approaches mutually consider routing and also link scheduling eg [11] [19] [20], Zhang et al [20] detailed joint routing and planning into an enhancement issue and tackled the issue with a segment age technique. Skillet et al [16] managed to the joint issue in subjective ratio systems considering the opening of authorized groups.

The calculations proposed in this work don't require any scheduling and the SASR calculations can be actualized in a disseminated way. In [21] the authors consider the exchange between spatial reuse and information rate, proposed a decentralized power and rate control calculation for higher system limit Zhai and Fany [22] researched the ideal bearer detecting range for throughput augmentation.

3. SYSTEM MODEL

Consider a static multi-hop wireless network with N nodes. Assume that the nodes have same transmission rate and do not have any power control constraint in this work.

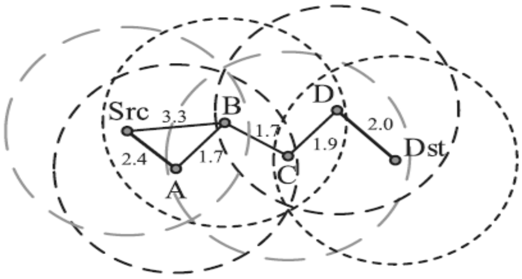

Fig 1. Importance of Spatial Reusability

Fig 1 shows a network with 6 nodes and each node's range is also shown. Each node's range is denoted by the circle with the node in its center. Each link is given an arbitrary cost. As wireless signal losses its energy in its prorogation, two wireless links can be worked at the same time, if they are far away from each other [13] [14]. If any pair of the nodes is out of the interfacing range of each other, we call it non-interfacing set I and a non-interfacing set can work at the same time [15].

Let's use an example from Fig 1. To represent the significance of spatial reusability of the correspondence media in single-path directing in a wireless system. Here we have four middle nodes (A, B, C, D) between source and destination. The dashed circle around each node demonstrate the range of the node. The cost is set apart close to each of the wireless link. There are two ways to reach the destination (Dst) from the source (Src).

Way 1: Src – B – C – D – Dst
Way 2: Src – A – B – C – D – Dst
In Way 1 cost is: 3.3+1.7+1.9+2.0 = 8.9
In Way 2 cost is: 2.4+1.7+1.7+1.9+2.0 = 9.7

Since Way 1 has lower cost it is likely to select it as the best path.

But considering the spatial reusability, we can see in Way 2, the link Src – A and link D – Dst are out of range of each other, and can work at the same time. It is important to combine spatially non-interfacing links while doing the path determination. By combine cost, we imply that cost of the non-interfacing set can be considered as single. On selecting a path with Src – A and D – Dst together, instead of adding both the cost, we select the one with higher cost only. So now the total cost of Way 2 can be lower to 7.7 which is less than the total cost of Way 1 i.e.; 8.9.

4. SPATIAL REUSABILITY AWARE SINGLE PATH ROUTING

We initially consider the spatial reusability-aware path cost assessment for single-path routing. Given each of the paths found by a current source routing algorithm (e.g., DSR [10]), our SASR calculation ascertains the spatial reusability aware path cost of it. At that point, the way with the small cost can be chosen.

The total SASR algorithm is proposed in two parts.

- SASR_MIN Algorithm
- SASR_FF Algorithm

4.1 SASR_MIN Algorithm

This algorithm takes the input of the entire network. A number of nodes, links and the cost of each node are its input. It finds all the possible path from the source node to destination node. And also finds all the non-interfacing set in the network. Starting from the source node it traverses each node to find the destination node. Finds all the possible path that connects the source node and destination node. Outputs of this part of SASR algorithm are paths from source to destination, their cost, and all the possible non-interfacing sets.

Algorithm

- Start from the source node.
- Traverse through the network to find the destination node.
- Save all possible path along with their cost.
- Considering the range of each node find possible non-interfacing sets and save it.
- Output the paths from source to destination, its cost and the non-interfacing set.

4.2 SASR_FF Algorithm

This algorithm takes the output of the SASR_MIN algorithm to find the path with the lowest cost of considering the concept of spatial reusability. It takes each path and traverses through it to find any element in non-interfacing set in it. If it finds a pair of non-interfacing nodes in the path, it combines the cost by only considering the highest cost among the non-interfacing nodes. Thus it finds the new cost for all possible paths from the source node to destination node. And compare the total cost of each path to find the new path with minimum cost.

Algorithm

- Take the output from SASR_MIN algorithm.
- Traverse through each path from source node to the destination node to find if they have any pair from the non-interfacing set that obtained as the output of SASR_MIN algorithm.
- On finding any pair of non-interfacing nodes in the path, combine the link costs of non-interfacing sets.
- For that, find the highest link cost link cost from the non-interfacing set and include only that cost while calculating the total cost of the path.
- Exclude the one with minimum link cost in a non-interfacing set of nodes.
- Compare between the new costs and select the one with minimum cost as the right path from source node to destination node.

5. EVALUATION

Here evaluated the performance of SASR_MIN and SASR_FF algorithm by using Java as the front end and wampserver as the back end. Evaluation is done on the assumption that all the nodes use same transmission rate. Comparison between traditional Dijikstra's algorithm and proposed SASR algorithm is done here.

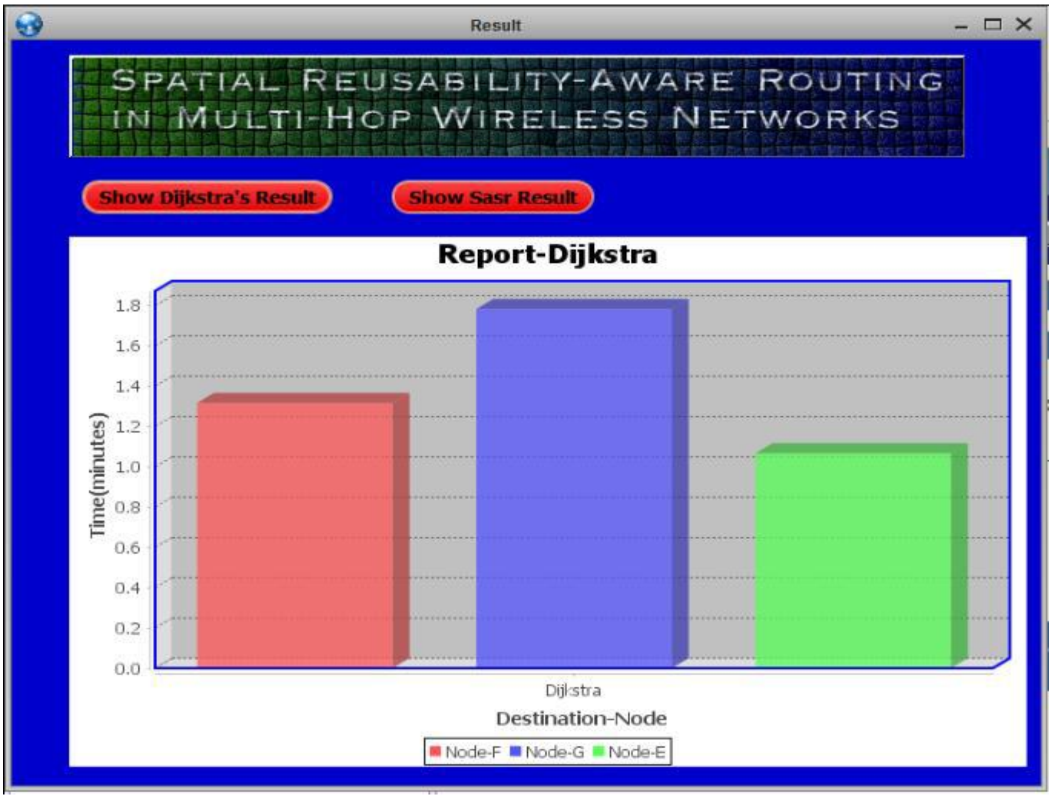

Fig 2. Packet Delay Measurement in Dijikstra's Algorithm

Fig 2 and Fig 3 shows the graph plotted for Dijikstra's and SASR algorithm. The comparison is done by considering that both the algorithm transmits the same data from source to destination. The graphs are a plot of nodes in the X-axis and delivery time in Y-axis. As the same packet is being transferred from source to destination, the packet size becomes constant.

Throughput = received size / time　　　　　　Equation 1

In Dijikstra's algorithm:

Time taken for packet delivery = 1.79 minutes i.e.; 107.4s

Throughput = 758400 / 107.4= 7061.45 bits/s

In SASR algorithm:

Time taken packet delivery = 0.43 minutes i.e.; 25.8s

Throughput = 758400 / 25.8 = 29395.34 bits/sec

For the above calculation same packet is transferred from source node to destination node. Node G is considered as the destination node. Packet size is 94.8 kb i.e.; 758400 bits. Packet delivery time is obtained from the Y-axis of both graphs, as the value is in minutes it is converted to seconds. Then both the values are substituted by Equation 1 to find the throughput. It is very evident that proposed SASR algorithm yields high throughput than he Dijikstra's algorithm.

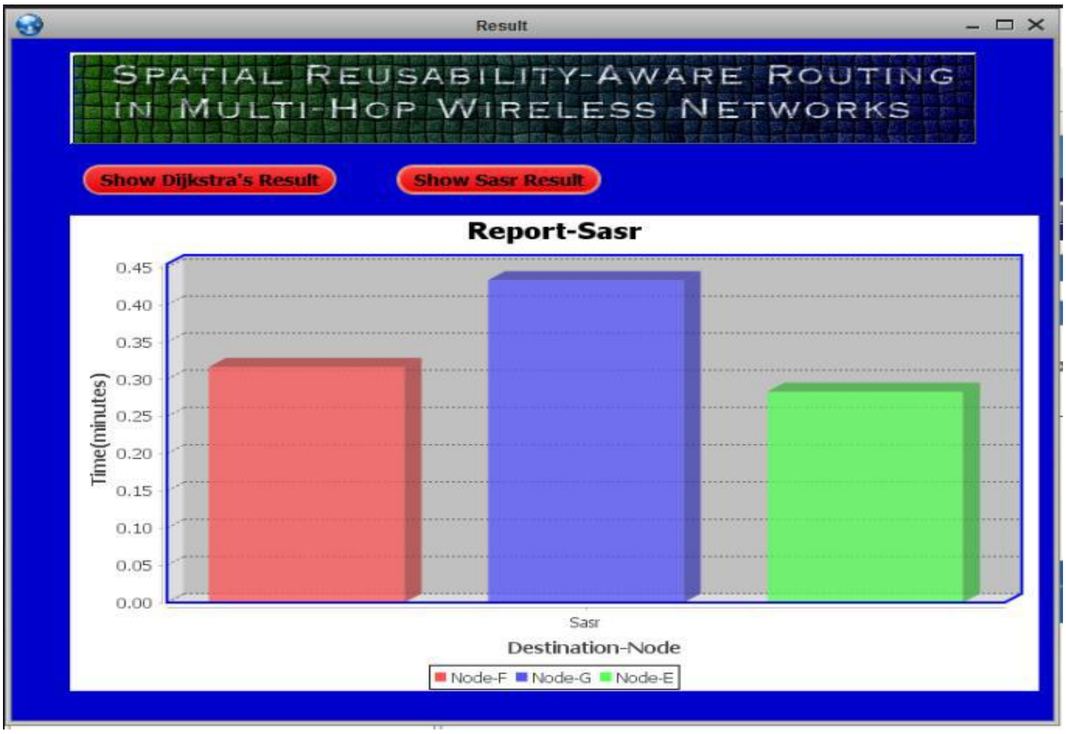

Fig 3. Packet Delay Measurement in SASR Algorithm

6. CONCLUSION AND FUTURE SCOPE

End-to-end throughput in multi-hop wireless systems can be tremendously improved by using spatial reusability of the wireless communication media. By taking this into consideration, introduced an algorithm, SASR for spatial reusability-aware single-path routing. The algorithm is proposed in two parts: SASR_MIN and SASR_FF algorithms. Both sub-algorithms combine to give a minimum cost- maximum end-to-end throughput path as output. An additional advantage of this system is that tremendous throughput gains only require acceptable additional transmission overheads. Implemented proposed protocol and compared it with existing routing protocols. Assessment demonstrated that SASR algorithm achieved more noteworthy end-to-end throughput increase under higher data rates. As a future work, the proposed system will be implemented in different constellation size and then evaluate and compare results with exiting protocols. Another direction is to further explore opportunities to improve the performance of our routing algorithms by analyzing special underperforming cases identified in the evaluation. Another direction is to incorporate a selection of path with AI to get a more optimized path.

7. REFERENCES

[1] A. Adya, P. Bahl, J. Padhye, A. Wolman, and L. Zhou, "A multi-radio unification protocol for IEEE 802.11 wireless networks," in Proc. 1st Int. Conf. Broadband Netw., 2004, pp. 344–345.

[2] S. Biswas and R. Morris, "Exor: Opportunistic multi-hop routing for wireless networks," in Proc. SIGCOMM Conf. Appl., Technol., Archit., Protocols Comput. Commun., 2005, pp. 133-144

[3] J. Broch, D. A. Maltz, D. B. Johnson, Y.-C. Hu, and J. G. Jetcheva, "A Performance Comparison of multi-hop wireless ad hoc network routing protocols," in Proc. 4th Annu. ACM/IEEE Int. Conf. Mobile Comput. Newt., 1998, pp. 85–97.

[4] S. Chachulski, M. Jennings, S. Katti, and D. Katabi, "Trading structure for randomness in wireless opportunistic routing," in Proc. SIGCOMM Conf. Appl., Technol., Archit. Protocols Comput. Commun., 2007, pp. 169–180.

[5] R. Cohen, and S. Havlin, (2003, Feb.). Scale-free networks are ultrasmall. Phys. Rev. Lett. [Online] 90, p. 058701. Available: http://link.aps.org/doi/10.1103/PhysRevLett.90.058701

[6] D. S. J. D. Couto, D. Aguayo, J. C. Bicket, and R. Morris, "A high throughput path metric for multi-hop wireless routing," in Proc. 9th Annu. Int. Conf. Mobile Comput. Netw., 2003, p 134–146.

[7] R. Draves, J. Padhye, and B. Zill, "Routing in multi-radio, multihop wireless mesh networks," in Proc. 10th Annu. Int. Conf. Mobile Comput. Netw., 2004, pp. 114–128.

[8] W. Hu, J. Xie, and Z. Zhang, "Practical opportunistic routing in high-speed multi-rate Wireless mesh networks," in Proc. 14th ACM Int. Symp. Mobile Ad Hoc Netw. Comput. 2013, pp. 127–136.

[9] G. Jakllari, S. Eidenbenz, N. W. Hengartner, S. V. Krishnamurthy, and M. Faloutsos, "Link. Positions matter: A noncommutative routing metric for a wireless mesh network," in Proc. IEEE 27th Conf. Comput. Commun., 2008, pp. 744–752

[10] D. B. Johnson and D. A. Maltz, "Dynamic source routing in ad hoc wireless networks," Mobile Comput., vol. 353, pp. 153–181, 1996.

[11] N. M. Jones, B. Shrader, and E. Modiano, "Optimal routing and scheduling for a simple network coding scheme," in Proc. INFOCOM, 2012, pp. 352–360.

[12] T.-S. Kim, J. C. Hou, and H. Lim, "Improving spatial reuse through tuning transmit power, carrier sense threshold, and data rate in multihop wireless networks," in Proc. 12th Annu. Int. Conf. Mobile Comput. Netw., 2006, pp. 366–377.
[13] R. P. Laufer, H. Dubois-Ferri_ere, and L. Kleinrock, "Multirateanypathrouting in wireless mesh networks," in Proc. INFOCOM, 2009, pp. 37–45.
[14] Y. Lin, B. Li, and B. Liang, "Codeor: Opportunistic routing in wireless mesh networks with segmented network coding," in Proc. IEEE Int. Conf. Netw. Protocols, 2008, pp. 13–22.
[15] J. Padhye, S. Agarwal, V. N. Padmanabhan, L. Qiu, A. Rao, and B. Zill, "Estimation of link interference in static multi-hop wireless networks," in Proc. Internet Meas. Conf., 2005, p 28
[16] S. Zhao, L. Fu, X. Wang, and Q. Zhang, "Fundamental relationship between node density and delay in wireless ad hoc networks with unreliable links," in Proc. 17th Annu. Int. Conf. Mobile Comput. Netw. 2011, pp. 337–348.
[17] C. E. Perkins and E. M. Belding-Royer, "Ad-hoc on-demand distance vector routing," in Proc. 2nd IEEE Workshop Mobile Comput.Syst. Appl., 1999, pp. 90–100.
[18] C. E. Perkins and P. Bhagwat, "Highly dynamic destination sequenced distance-vector routing (DSDV) for mobile computers," in Proc. Conf. Commun. Archit., Protocols Appl., 1994, pp. 234–244.

