

# MULTIPLE PARAMETER ANALYSIS ON WIRELESS NETWORK USING SPATIAL REUSABILITY

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**Abstract:** The selection of optimal route from source node to destination node that guarantees a high end-to-end throughput, is the main issue of routing in multi hop wireless network especially in a multi objective and heterogeneous scenario. As the environment is heterogeneous and various parameters affect the system performance in varying scale, the issue seems to be much complex, most of the solutions end with local optimum because those algorithms mostly fail to ensure not only end to end throughput, but also other parameters of routing like delay, congestion control, energy of nodes etc. By considering spatial reusability of wireless networks, all these parameters of wireless multi hop remote systems can be enhanced significantly. To achieve the expected performance, Spatial-reusability Aware Single-path Routing (SASR) algorithm is proposed and to analyze the performance the same is compared with existing single path routing protocol. Assessment shows that proposed protocol shows significant improvement in comparison with existing protocols.

**Index Terms:** Wireless network, spatial reusability, routing

## I. 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 augment the end-to-end throughput, particularly in multi hop wireless network. A principle issue with existing wireless routing protocol is that limiting number of transmission to convey a single packet from source node to destination node does not rely augment 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. Large portion of existing protocols, link quality aware routing. They just select the path that limit 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 far distance. But existing protocols do not take this into consideration.

## II. RELATED WORK

In this area a quick review on 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 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 Dijkstra’s algorithm for selecting 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 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.

### III.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.

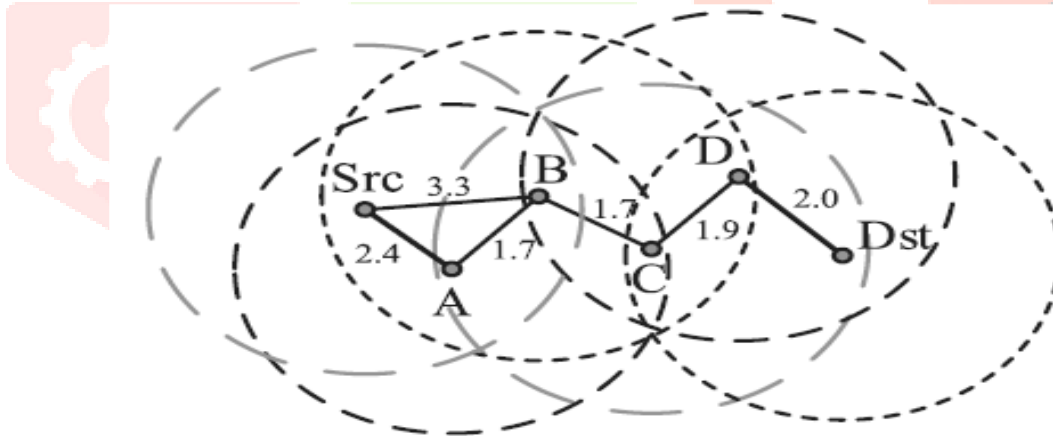


Fig 1. Importance of spatial reusability

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 same time, if they are far away from each other [13] [14]. If any pair of the nodes are out of the interfacing range of each other, we call it non-interfacing set I and a non-interfacing set can work at same time [15].

Let’s use an example from Fig 1. to represent significance of spatial reusability of the correspondence media in single-path directing in 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 destination (Dst) from the source (Src).

First Path: Src – B – C – D – Dst

Second Path: Src – A – B – C – D – Dst

First Path Cost = 8.9 (3.3+1.7+1.9+2.0) Equation 1

Second Path Cost = 9.7 (2.4+1.7+1.7+1.9+2.0) Equation 2

Since First Path have lower cost it is likely to select it as the best path.

But considering the spatial reusability, we can see in Second Path, 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 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 Second Path can be lower to 7.7 which is less than total cost of First Path i.e.; 8.9.

#### IV. 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.

1. SASR-MIN algorithm
2. SASR-FF algorithm

##### 4.1 SASR-MIN algorithm

This algorithm takes the input as the entire network. Number of nodes, links and the cost of each node is 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.

##### SASR-MIN

1. Start from the source node.
2. Traverse through the network to find the destination node.
3. Save all possible path along with their cost.

4. Considering the range of each node find possible non-interfacing sets and save it.
5. 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 lowest cost on considering the concept of spatial reusability. It takes each path and traverse 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 source node to destination node. And compare the total cost of each path to find the new path with minimum cost.

##### SASR-FF

1. Take output from SASR-MIN algorithm.
2. Traverse through each path from source node to destination node to find if they have any pair from the non-interfacing set that obtained as the output of SASR-MIN algorithm.
3. On finding any pair of non-interfacing nodes in the path, combine the link costs of non-interfacing sets.
4. 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.
5. Exclude the one with minimum link cost in non-interfacing set of nodes.
6. Compare between the new cost and select the one with minimum cost as the right path from source node to destination node.

#### V. EXPERIMENT AND RESULT

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 Dijkstra's algorithm and proposed SASR algorithm is done here.

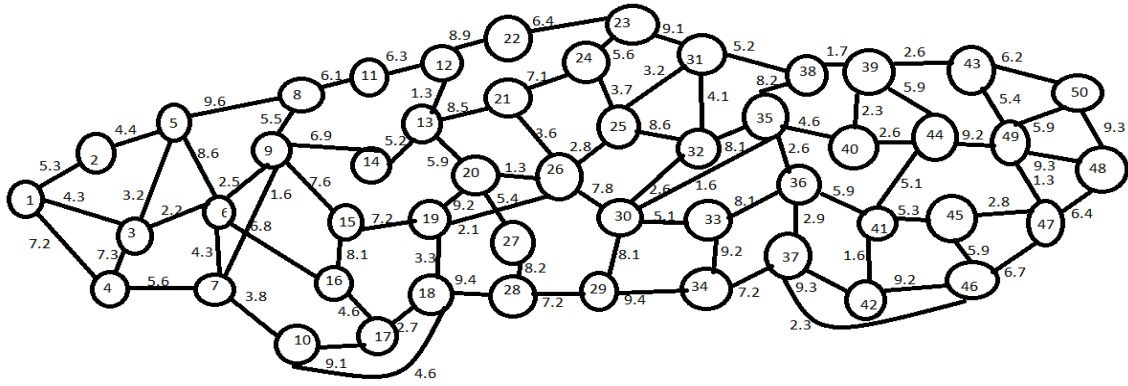


Fig 1. Typical network model

A network model of 50 nodes, Fig 1, is taken as the system model to execute the algorithms and evaluate its performance for different network parameters

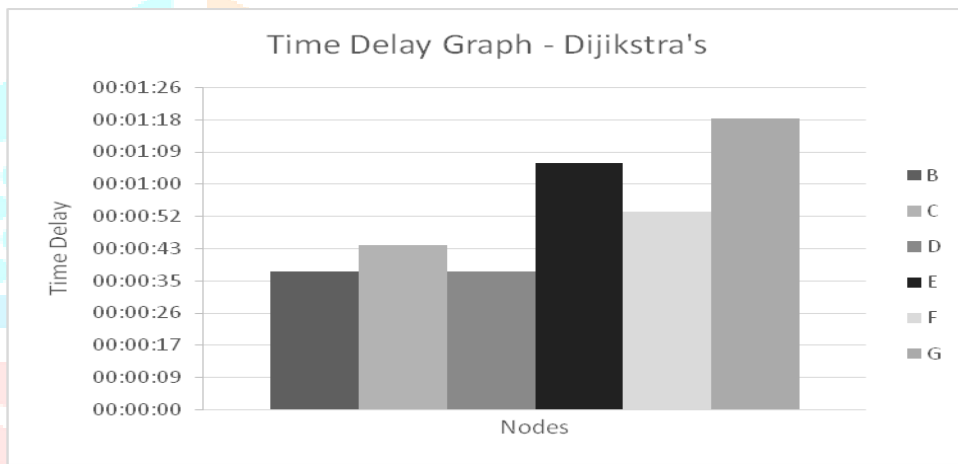


Fig 2. Packet delay measurement in Dijkstra's algorithm

Fig 2 and Fig 3 shows the graph plotted for Dijkstra's and SASR algorithm. Comparison is done on 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 become constant.

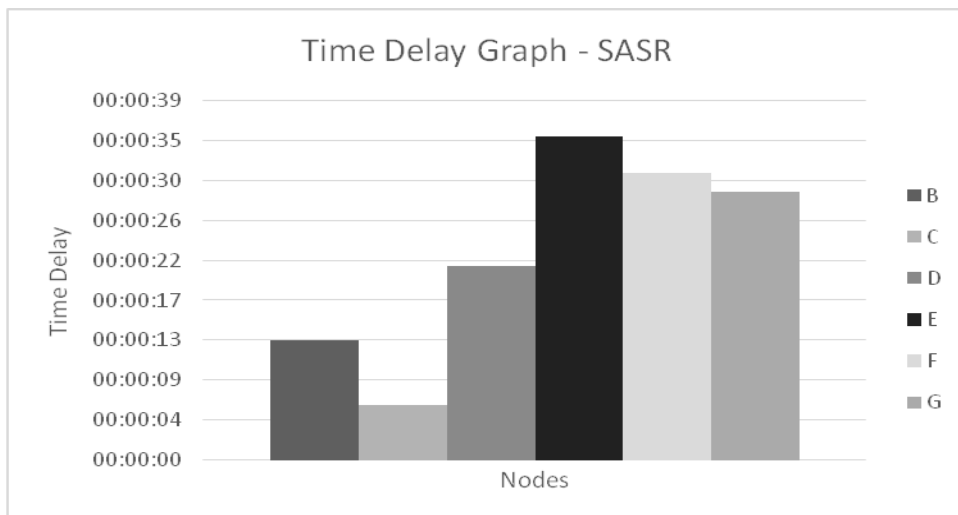


Fig 3. Packet delay measurement in SASR algorithm

$$\text{Throughput} = \text{received size} / \text{time}$$

Equation 1

In Dijkstra’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 to Equation 1 to find the throughput. It is very evident that proposed SASR algorithm yields high throughput than the Dijkstra’s algorithm.

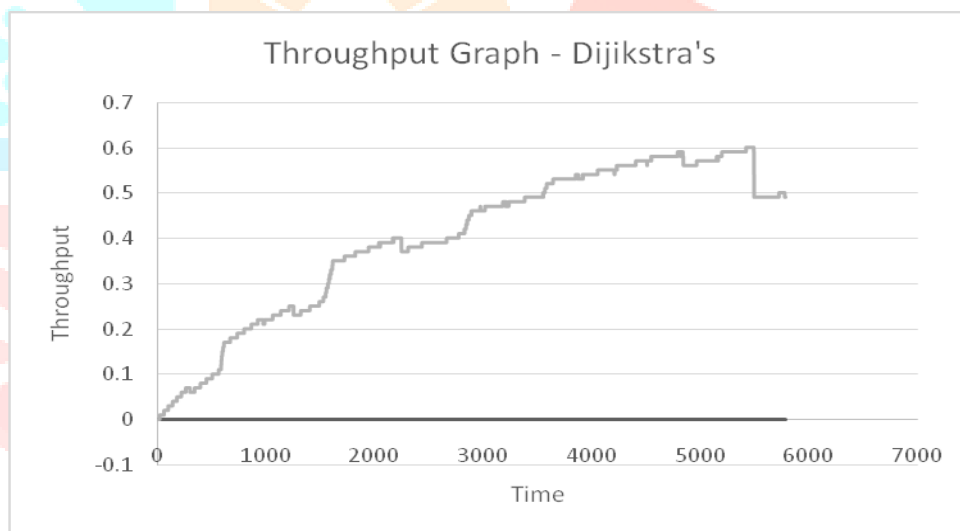


Fig 4. Throughput graph for Dijkstra’s Algorithm

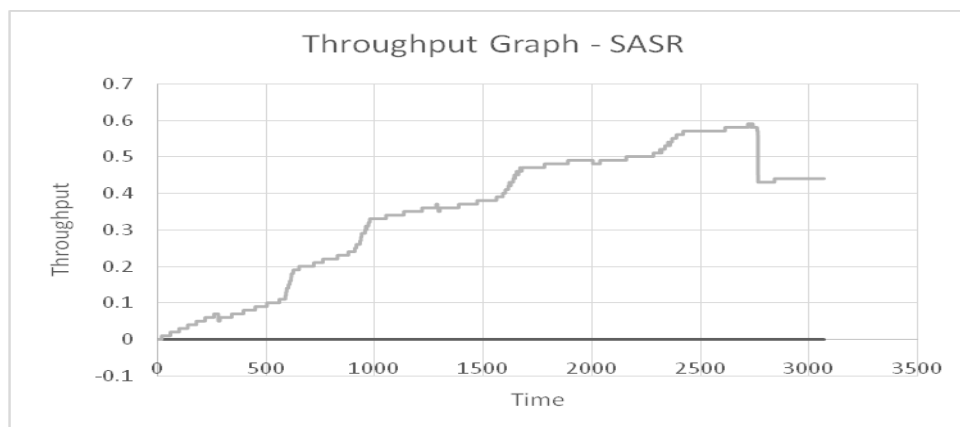


Fig 5. Throughput graph for SASR Algorithm

Congestion window size of a routing algorithm refers to number of packets that can be send simultaneously through a path. By comparing the congestion window size of SASR and Dijkstra’s algorithm the result obtained shows that congestion window size of SASR algorithm is much higher than that of Dijkstra’s. Fig. 6 and Fig.7 shows the plot of congestion window of SASR and Dijkstra’s respectively.

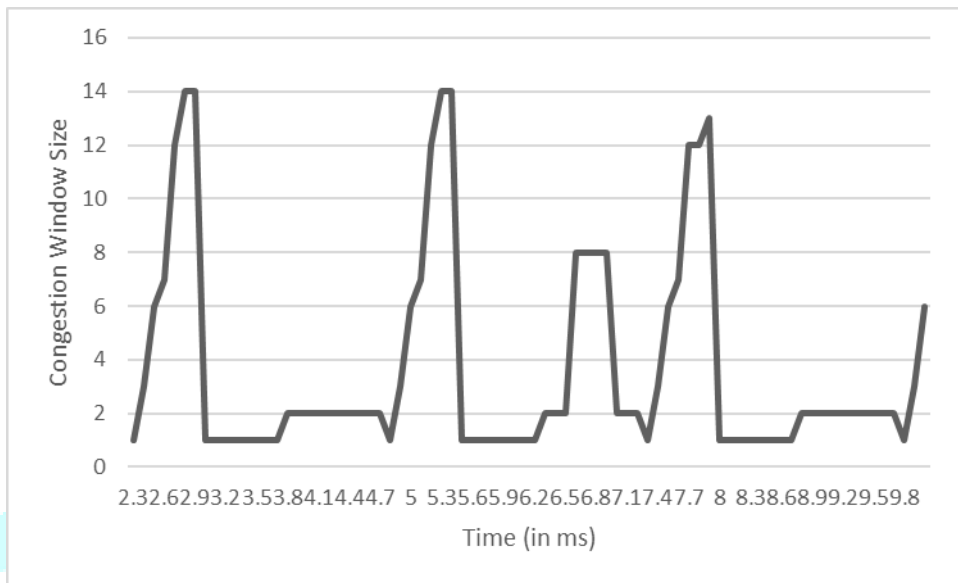


Fig. 6 Conjestion Window in SASR

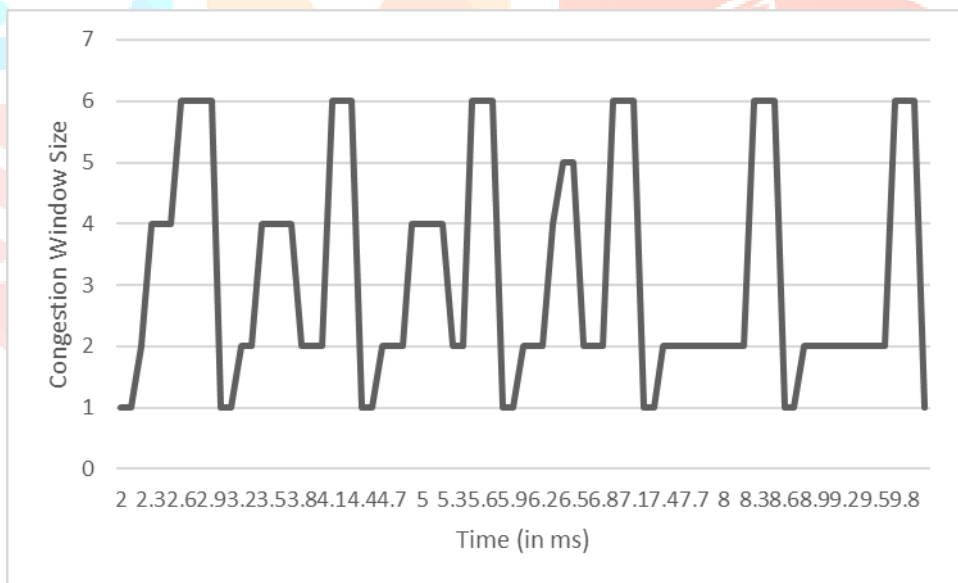


Fig 7. Congestion Window in Dijkstra’s

### VI. CONCLUSION AND FUTURE SCOPE

Different parameters 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. 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. 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 tremendous performance under higher data rates. As a future work, proposed system will be implemented in different constellation size and then evaluate and compare results with exiting protocols. Another direction is to incorporate selection of path with AI to get a more optimized path.

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