Congestion Reduced Routing

Using WDM Network

4th Semester

Mini Project under guidance of Prof. Uma Bhattacharya

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4th Semester Mini-Project

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Signature of supervisor with date

2.

Signature of Head of Department

Contents

ACKNOWLEDGEMENT

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Introduction

Data transmission is an important part of modern day technologies.The more efficiently data is being transmitted the more easy it is for people to communicate.

Hence this project aims at making the transmission of data more smooth and efficient.

Here we deal with modes of routing within a network and compare among them to decide the most efficient among them.

Optical Networks

- Lightwave propagates through optical fibres by using total internal reflection.

- Low signal attenuation - As signal propagates through fibers, the signal strength goes down at a low rate (0.2 db/km). This means that the number of optical amplifiers needed is relatively low.

- Optical networks have found widespread use because the bandwidth of such networks using current technology is 50 terabits per second.

Constraint:

The optical connection between two corresponding nodes is taken to be limited by the number of channels in each fibre link.

Wavelength Division Multiplexing (WDM)

- The technology of using multiple optical signals on the same fiber is called Wavelength Division Multiplexing (WDM).

- Different Channels are multiplexed within the large bandwidth provided by the optical network.

Characteristics of WDM Network

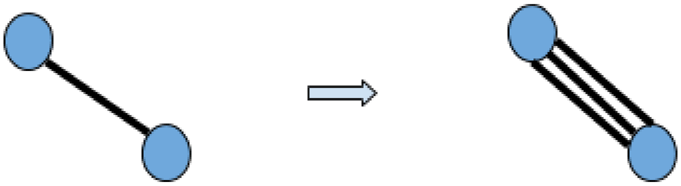
Wavelength-division multiplexing (WDM) is a method of combining multiple signals on laser beams at various infrared (IR) wavelength for transmission along fiber optic media.

Some major properties of WDM Network :

- Link Capacities
- Number of Transceivers
- Static or Dynamic Environments

Link Capacity

It denotes the number of channels per link in a WDM Network.
For example if the link capacity is 3, then the number of channels per link in the network is fixed.
So the link capacity is fixed in a WDM Network.



Link capacity = 3

Number of channels per link = 3

Number of Transceivers

A combination of a transmitter and a receiver is called a transceiver; it converts an electrical signal to and from an optical signal.The nodes in the network can be denoted as transceivers.
Ocne node receives the signal and transmits it to the next node.
Thus, in a particular WDM Network, the number of transceivers is fixed.

Static/ Dynamic Environment

Static Environment

In this case, the request set for source and destination is fixed and hence the set is static (does not change).

Dynamic Environment

The request set in this case is always dynamically changing as the algorithm is executed.

The Problem

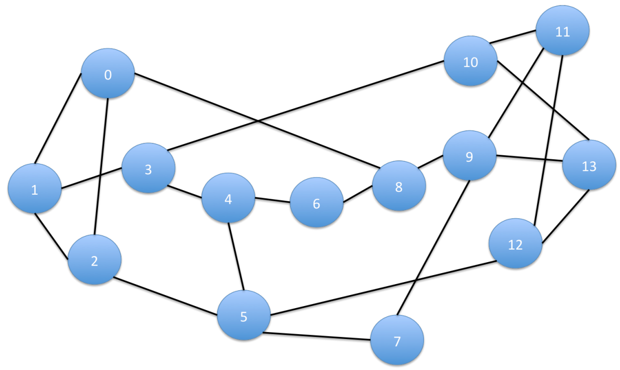
- Problem Definition
- Functions Defined

Problem Definition

Given the NSF (14 node) network with edge weights, set of static requests and with certain link capacity,

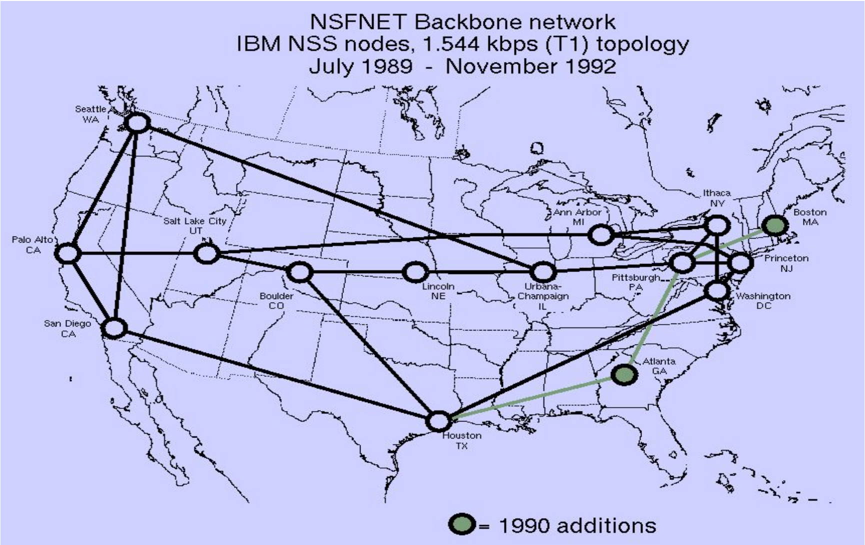
Find the congestion reduced routing maintaining the shortest path constraint as far as possible.

Physical Topology for NSF net



The **National Science Foundation Network(NSFNET)** was a program of coordinated, evolving projects sponsored by the National Science Foundation (NSF) beginning in 1985 to promote advanced research an education networking.

- NFS net is a 14 node network . With each node with a degree greater than 1.
- The graph has bidirectional links.
- to the nation's NSF-funded supercomputing centers, forming the Internet backbone.

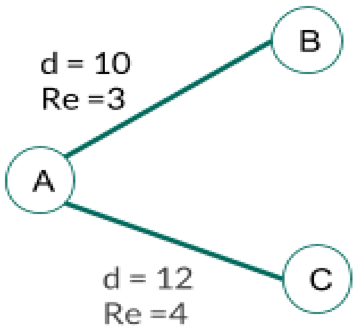


Functions Defined

We define two functions here to reduce congestion and also to consider the shortest path from a given source to destination node.

- Distance Ratio
- Availability Ratio

Distance Ratio



Number of channels = 5

Number of requests through AB = 3
Number of requests through AC =4
Distance of link AB = d(AB) = 10
Distance of link AC = d(AC) = 12

d = distance of the link
Re =Number of Requests through the link

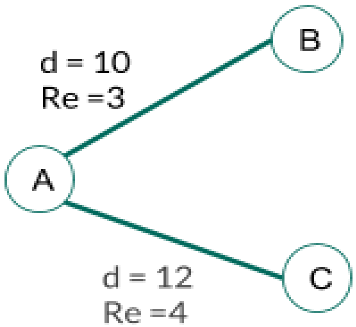
For link AB:

Distance ratio :
d(AB)/(d(AB) + d(AC)) = 10/22

For link AC:

Distance ratio :
d(AC)/(d(AB) + d(AC)) = 12/22

Availability Ratio



For link AB:
Channel available = (channel -Re) = (5-3)=2
Availability Ratio = (2/5)

For link AC:
Channel available = (channel -Re) = (5-4)=1
Availability Ratio = (1/5)

$$\text{Availability Ratio} = \frac{\text{Channel available}}{\text{number of channels}}$$

Shortest Path Routing

For a given source and destination, we chose the path that has the minimum weight.

Congestion Reduced Routing

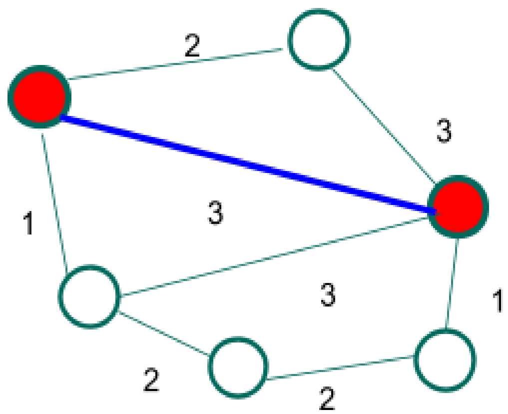
For a given source and destination, we chose that path where we have the maximum channels available and hence less congestion.

Shortest Path Routing

We first check all possible paths from the given source and the given destination node

And then chose that path that has the minimum weight.

In this case, the path between the given source and destination(both marked red) is the path marked blue having minimum weight 3.



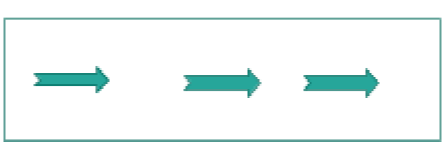
Congestion Reduced Routing

- To reach a particular destination from a given node, the signal propagates through that path that has maximum channels available.
- So ,if there exists a path (S) from a given node to another node and the number of channels available in that path is more than that available in any other path (L), then signal propagates through S instead of L.

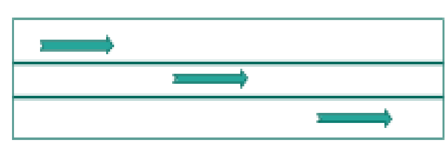
Blocking defined

Each edge in the network has a constant link capacity (a fixed number of channels).

Link

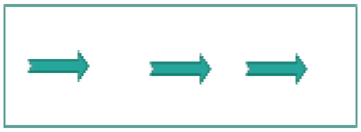


Channels within a link

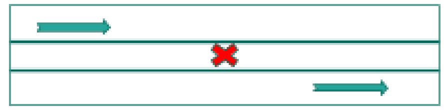


Assuming Link Capacity = 3

Link

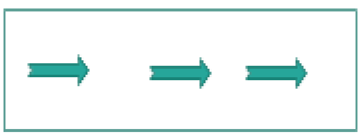


Channels within a link

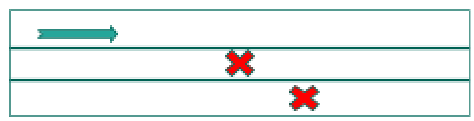


After passing of data packet through a particular channel, that channel can not be used again.

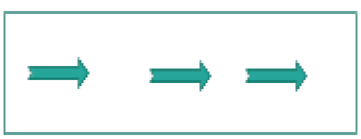
Link



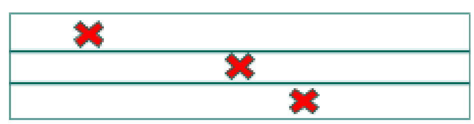
Channels within a link



Link



Channels within a link



All the channels have been used up and hence the link gets blocked. So no data packet can use this link for further data transfer.

The Algorithm

Probability of choosing a path

The probability of choosing an optimum path depends on both least congestion and minimum weighted path.

So , P = $(availability\ ratio)^{a} * (1 - distance\ ratio)^{b}$

Hence, we chose that path in which our probability turns out to be maximum.

Varying the values of a and b we choose the path where the given probability is maximum.

a ,b are some constants

Optimal Path

In our case, we first find all possible paths between source and destination node and calculate the probability for each path.

Probability for each path is calculated by summing up the availability ratio and distance ratio for each edge in the path and then applying the given formula.

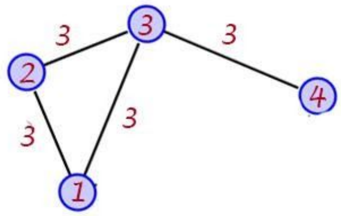
We then chose the path whose probability comes out to be maximum.

Blocking

Blocking refers to the process where the edge between two nodes are no longer available to pass the request.

In our case , the constraint that the link capacity is fixed and set to values 3,4 and 5 respectively. This implies that whenever the request is processed the corresponding link capacity is reduced by one. Once the maximum link capacity is reached , then the corresponding edge is blocked thereby no request can be processed through the edge further. Example is as follows:

AN EXAMPLE OF BLOCKING



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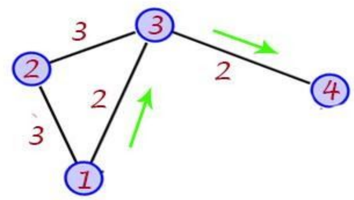
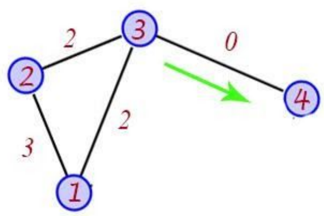


Request 1 - 4

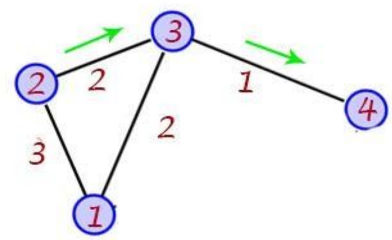
↓ Request 2

-4

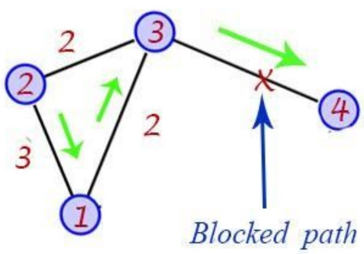


Request 3 -4

←

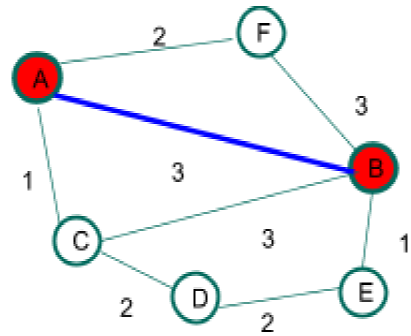


↓ Request 3 - 4 (Channel Blocked)



Pseudocode

```
def next_node(s):
    nxt = []
    for i in range(NODES):
        if(distance_links[s][i] != INVALID):
            nxt.append(i)
    return nxt
```

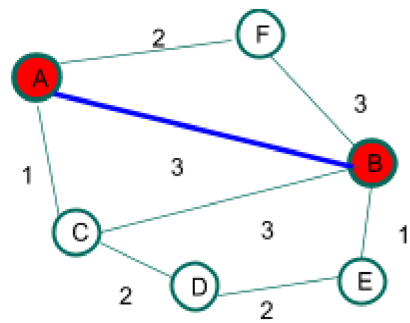


for example - next_node(A) = [B,C,F]

def **simple_paths**(source, dest):

find all paths from source to dest

store the paths in an array (say path_array)



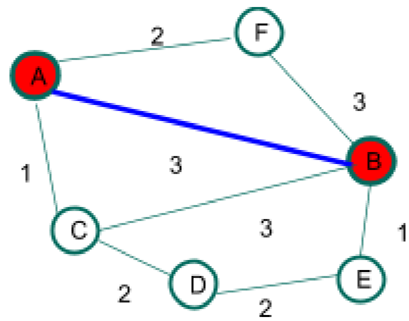
For example

path_array =simple_paths(A,B) = [A->B], [A->F->B], [A-> C ->B], [A-> C ->D-> E-> B] def **availability_ratio**(source,dest):

Check every path in pathlist

for every edge in a path calculate Availability ratio.

Take the sum of such ratio for all edges in the path.



AR = cha[A -> B] + cha[A -> F -> B] + cha [A -> C -> B] + cha[A -> C ->D-> E-> B]

cha = channels available for that path (number of channels remaining)

availability_ratio(A,B) = (cha[A -> B])/ AR

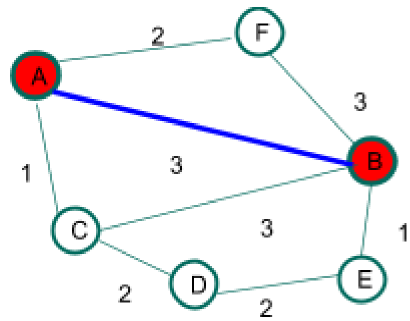
Likewise we store availability ratios of all such paths.

def **distance_ratio**(source,dest):

Check every path in path_array

for every edge in a path calculate Distance Ratio.

Take the sum of such ratio for all edges in the path.



D = dist [A -> B] + dist[A -> F -> B] + dist [A -> C -> B] +dist [A -> C ->D-> E-> B]
= 3 + 5 + 4 + 6 = 18 (in this example)

Distance ratio for path [A -> B] = (dist [A -> B]) / D = (3/18)

Distance ratio for path [A -> F -> B] = (dist[A -> F -> B]) / D = (5/18)

Likewise we store distance ratio of all such paths.

def **probability**(source,dest):

For every path in the path_array

Calculate P = $(availability\ ratio)^{a} * (1 - distance\ ratio)^{b}$

Store it in a list called probability_array

probability(A,B) = calculating probability for all paths in path_array for A to B and storing them in a list (say probability_array)

def **max_prob**(A,B):

return max probability from the probability_array

Out of all such probabilities in the probability_array , calculate the maximum probability for source A and destination B.

Results

There are three cases

- a > b
- a = b
- a < b

a > b - indicates Higher Priority is given to congestion.

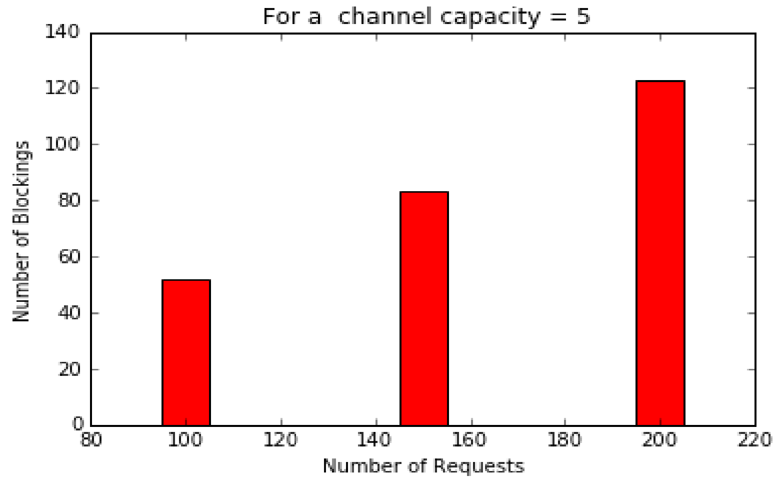
a = b - indicates same priority given to both congestion and distance.

a < b - indicates higher priority is given to shortest distance.

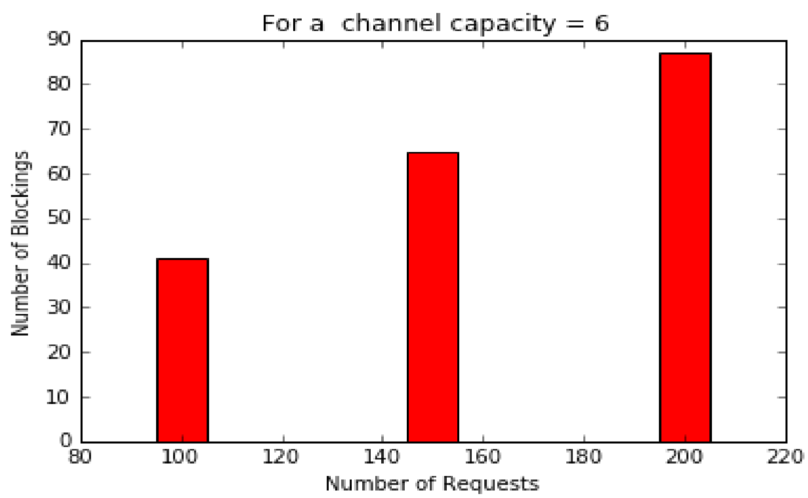
Graph Characteristics

For a > b

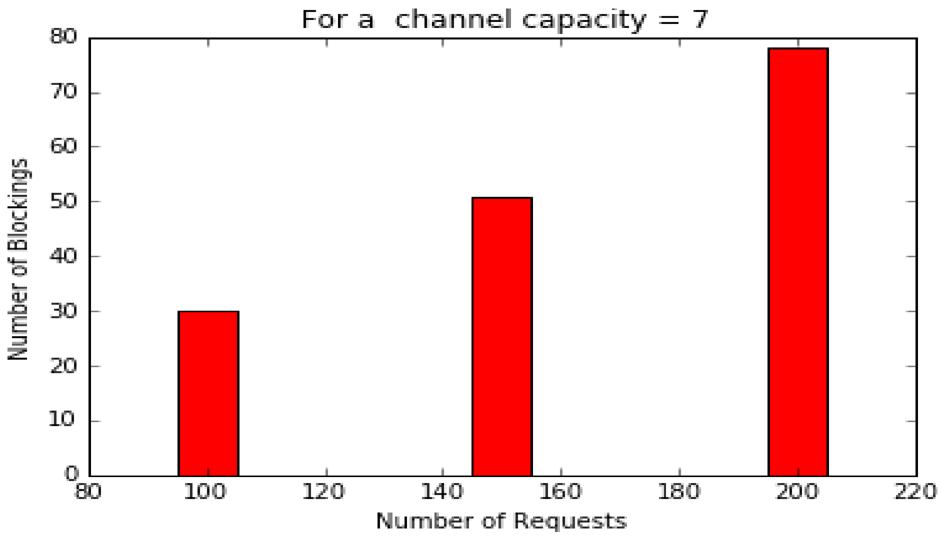
Plotting between blockings and number of request sets for a given channel capacity



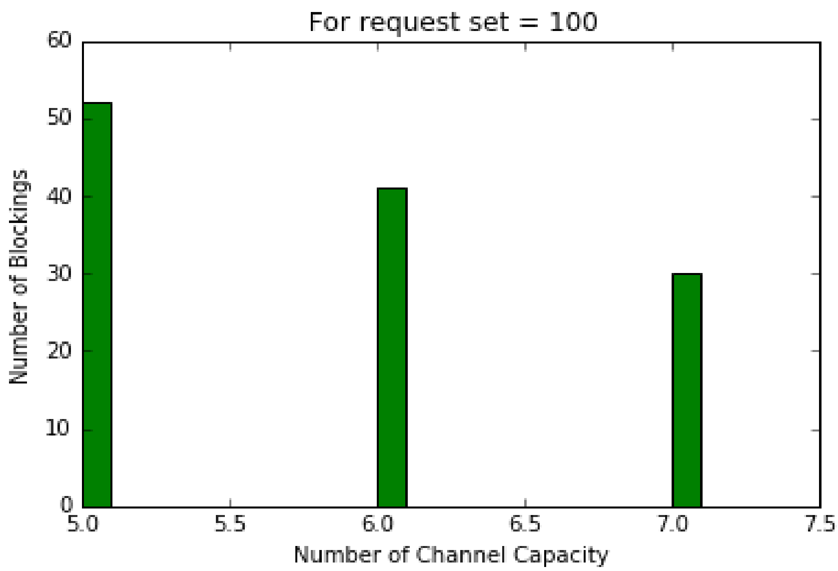
Plotting between blockings and number of request sets for a given channel capacity



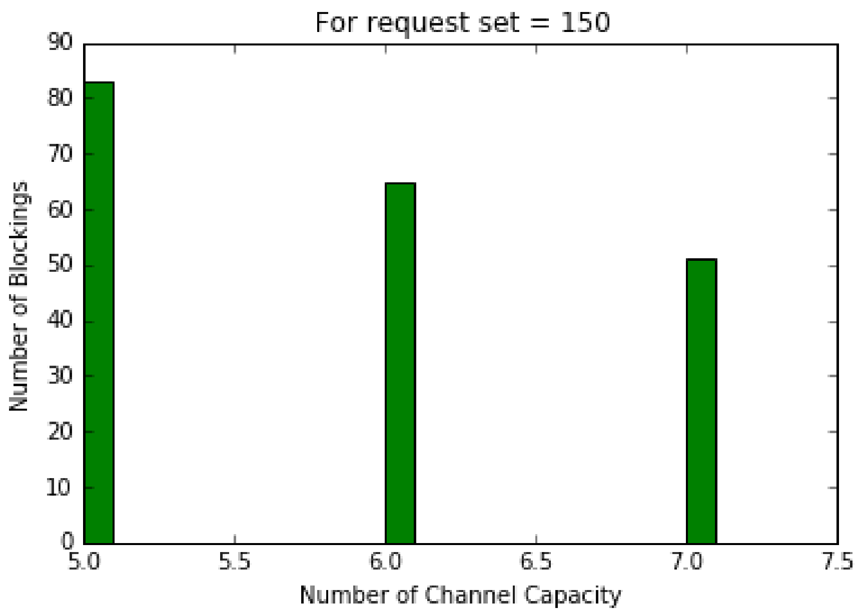
Plotting between blockings and number of request sets for a given channel capacity



Plotting between blockings and channel capacity for given number of request set

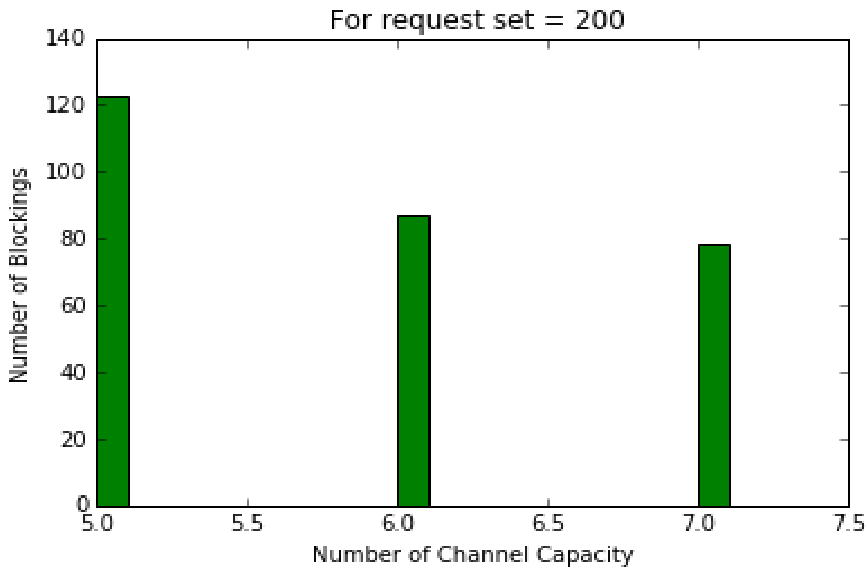


Plotting between blockings and channel capacity for given number of request set



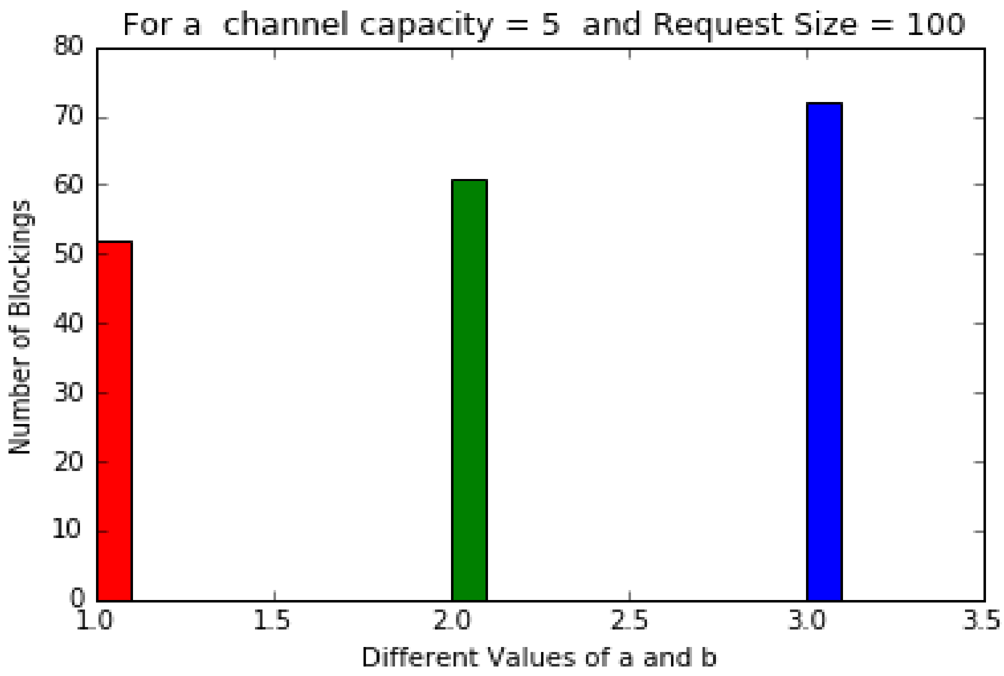
Plotting between blockings and channel capacity

for given number of request set



We get the same characteristics for both a = b and a < b.

Checking for blocking under different values of a and b for a given request set and channel capacity



Red : (a > b)
Green : (a = b)
Blue : (a < b)

Result Table

Capacity	Number of Requests	a > b	a =b	a < b
5	100	52	61	72
5	150	83	95	117

5	200	123	136	155
6	100	41	48	56
6	150	65	78	84
6	200	87	105	123
7	100	30	36	39
7	150	51	59	71
7	200	78	98	112

Observation

- So as the link capacity increases, the no. of blockings decreases.
- As the number of requests increases, the no. of

blockings increases.
- The congestion is minimum in case of (a > b) and increases gradually and becomes maximum in case of (a < b).

Hence, as we increase 'a' , that is giving priority to congestion, then
the number of blocking reduces.

Conclusion

- We observe that the number of blockings get reduced when we use congestion reduced routing.

- Thus we can conclude that Congestion reduced routing in WDM Network reduces blocking and hence can preferred more for data transfer operation.

Thank You