CS252

LAB-5

Name: Deepanshu

Roll number: 190050032

Question 1

a)

Without RTS/CTS:

Per Node througput for node 0 = 19.0921

Per Node througput for node 1 = 9.71408

Per Node througput for node 2 = 9.37797

Total channel throughput = 19.0921

With RTS/CTS:

Per Node througput for node 0 = 20.2073

Per Node througput for node 1 = 10.1113

Per Node througput for node 2 = 10.096

Total channel throughput = 20.2073

b)

Without RTS/CTS

10% Offerload => Total channel throughput = 5.45414

20% Offerload => Total channel throughput = 10.8344

30% Offerload => Total channel throughput = 16.3675

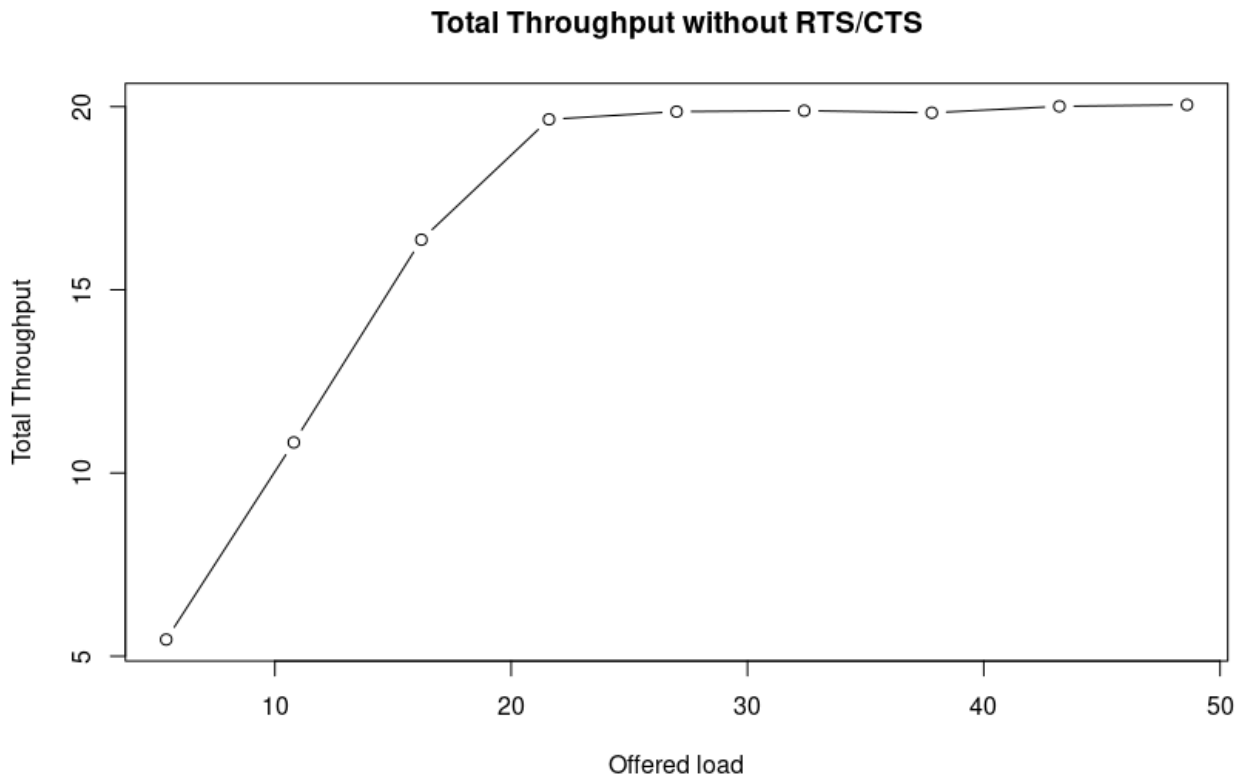40% Offerload => Total channel throughput = 19.6522

50% Offerload => Total channel throughput = 19.8636

60% Offerload => Total channel throughput = 19.889

70% Offerload => Total channel throughput = 19.833

80% Offerload => Total channel throughput = 20.0087

90% Offerload =>Total channel throughput = 20.0495

Total Throughput without RTS/CTS

With RTS/CTS

10% Offerload => Total channel throughput = 5.45414

20% Offerload => Total channel throughput = 10.9108

30% Offerload => Total channel throughput = 16.3675

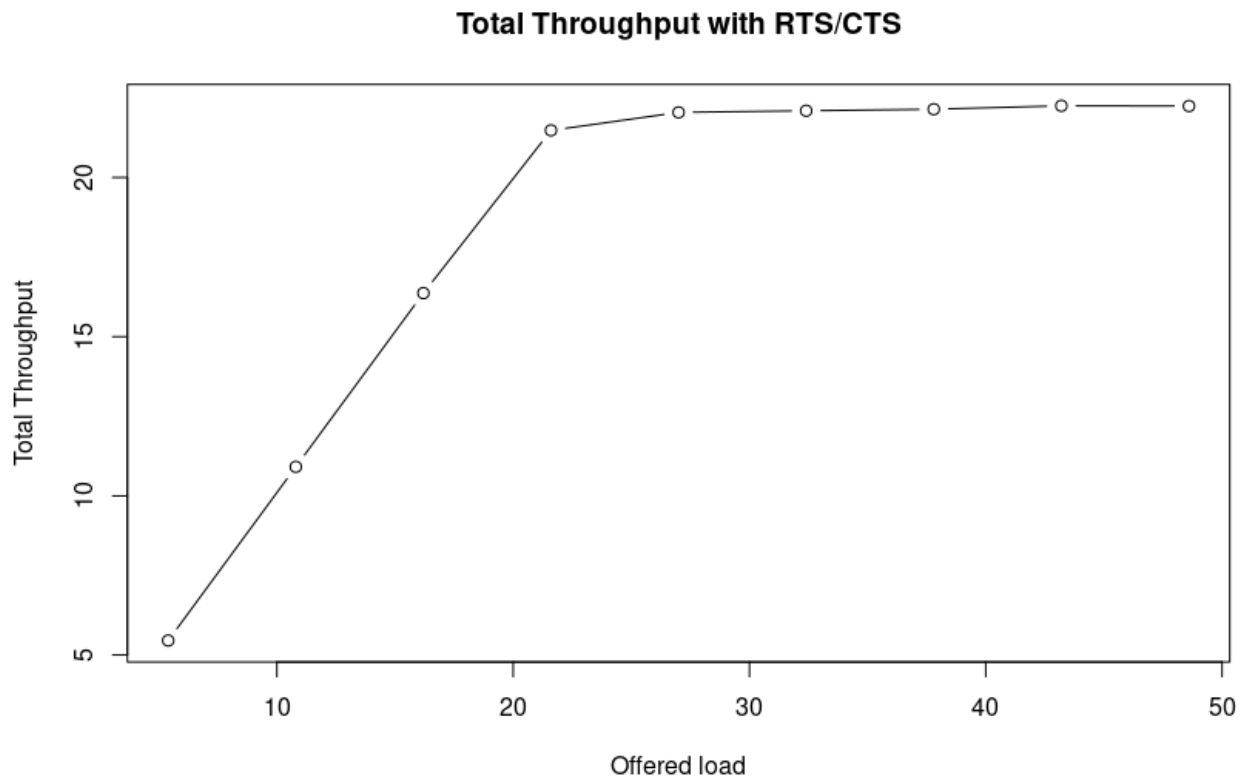40% Offerload => Total channel throughput = 21.4805

50% Offerload => Total channel throughput = 22.0457

60% Offerload => Total channel throughput = 22.0967

70% Offerload => Total channel throughput = 22.145

80% Offerload => Total channel throughput = 22.252

90% Offerload => Total channel throughput = 22.2444

Total Throughput with RTS/CTS

C)

%age Offerload	Without RTS/CTS	With RTS/CTS
10%	5.45924	5.45924
20%	10.921	10.921
30%	16.3830	16.3830
40%	21.842	21.842
50%	25.6156	22.6645
52%	25.6564	22.6645
55%	25.6156	22.6569
60%	25.6156	22.6288
70%	25.6182	22.6288
80%	25.6182	22.6288
90%	25.6182	22.6288

So in Without RTS/CTS case we can see that 52% is the maxima. Though we can go for more partition here but on a large scale we can comment that 52% is the maxima.

Similarly, With RTS/CTS case we can see that Maxima will be between 50-52%. Again this is a large scale resut we are not dividing more.

d)

When RTS/CTS was not enabled, collisions will occur at much faster rate then collisions with RTS/CTS (Note that this is because here node 1 and node 2 are sending data and **can not** CS each other).

When we keep increasing Offerload, both in With and Without RTS/CTS, Throughput will almost saturate after certain offerload. Though we can observe small variations in Throughput to watch the maxima both in With and Without RTS/CTS.

Also the corresponding value of "With RTS/CTS" is smaller then "Without RTS/CTS" because RTS/CTS will take time and even without RTS CTS there will be no collision, and hence the result.

Question 2

Connect n0-n1 and n1-n2 and n0-n2

a)

Without RTS/CTS

10% Offerload => Total channel throughput = 5.45414

20% Offerload => Total channel throughput = 10.9108

30% Offerload => Total channel throughput = 16.3675
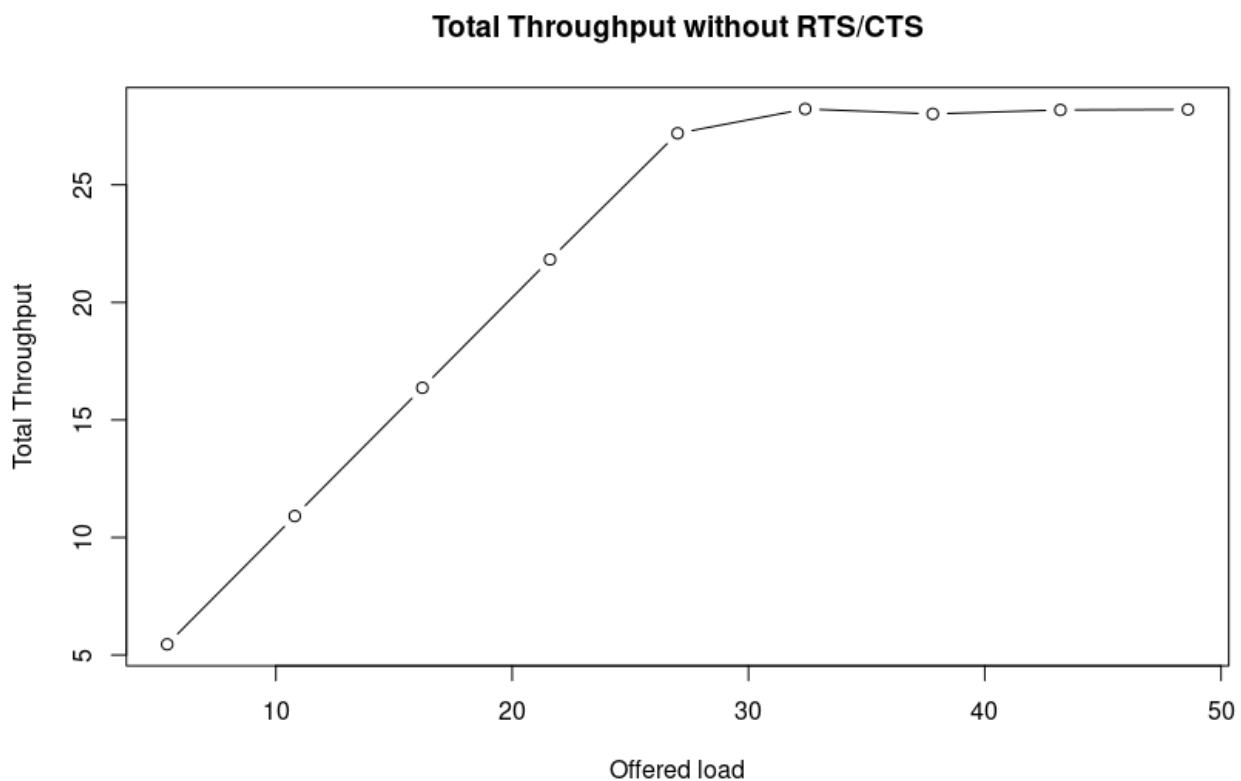
40% Offerload => Total channel throughput = 21.8242

50% Offerload => Total channel throughput = 27.1943

60% Offerload => Total channel throughput = 28.2281

70% Offerload => Total channel throughput = 28.0193

80% Offerload => Total channel throughput = 28.1874

90% Offerload =>Total channel throughput = 28.2078

Total Throughput without RTS/CTS

10% Offerload => Total channel throughput = 5.45414

20% Offerload => Total channel throughput = 10.9108

30% Offerload => Total channel throughput = 16.3675

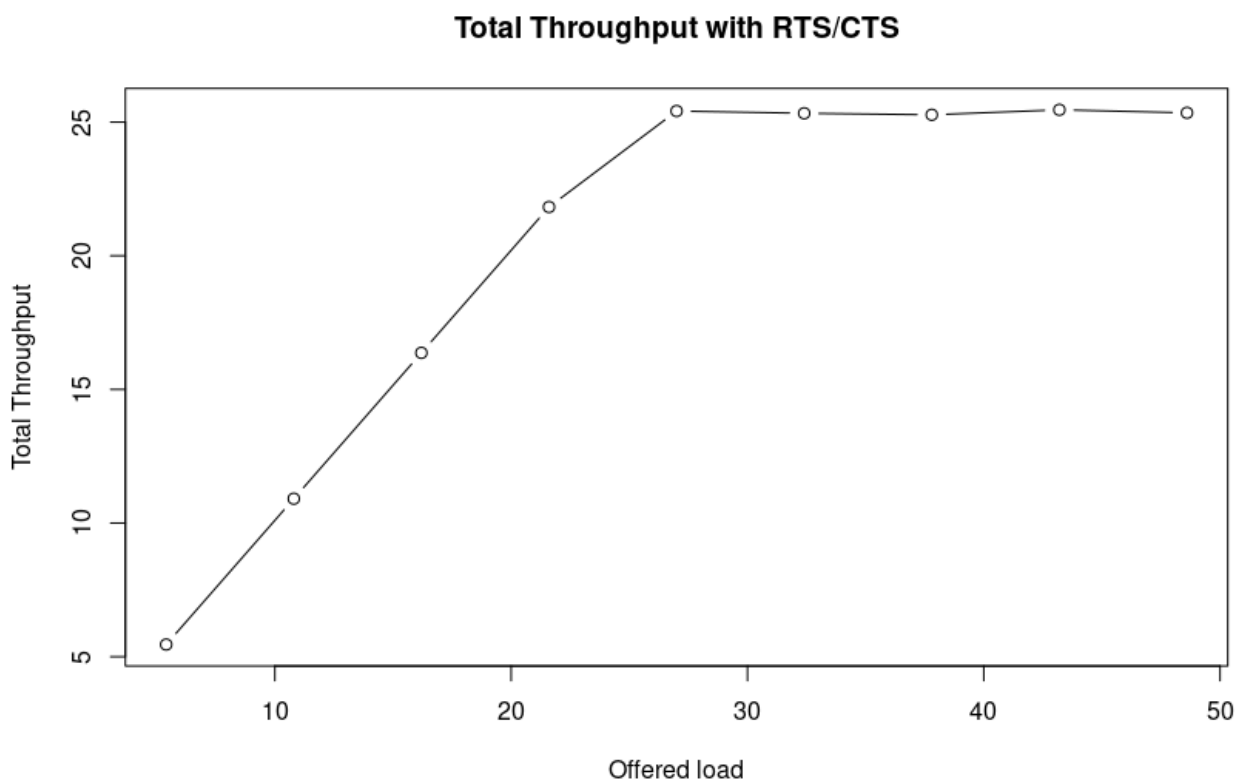40% Offerload => Total channel throughput = 21.8242

50% Offerload => Total channel throughput = 25.4145

60% Offerload => Total channel throughput = 25.3305

70% Offerload => Total channel throughput = 25.2744

80% Offerload => Total channel throughput = 25.4603

90% Offerload => Total channel throughput = 25.3483

Total Throughput with RTS/CTS

b)

Here trend is just opposite from the previous question, i.e., here Without RTS/CTS value are greater then With RTS/CTS.

This is because, now n1 and n2 (who are sending data to n0) can CS each other unlike previous question. So RTS/CTS is wasting time and much collisions can be tackelled with CS and hence the Without RTS/CTS method id more successful.

Question 3

a)
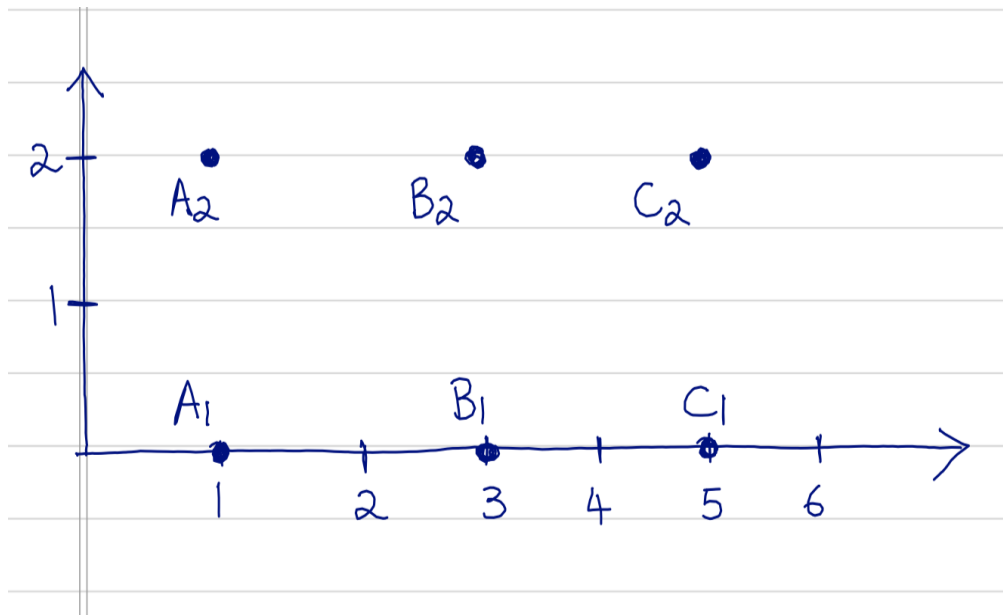
With RTS/CTS:

Per Node througput for node A1 = 10.1062

Per Node througput for node A2 = 10.1062

Per Node througput for node B1 = 9.62496

Per Node througput for node B2 = 9.62496

Per Node througput for node C1 = 10.0807

Per Node througput for node C2 = 10.0807

Total channel throughput = 29.8119

b)

With RTS/CTS

10% Offerload => Total channel throughput = 5.44651

20% Offerload => Total channel throughput = 10.9006

30% Offerload => Total channel throughput = 16.3548

40% Offerload => Total channel throughput = 21.8064

50% Offerload => Total channel throughput = 27.258

60% Offerload => Total channel throughput = 31.2989

70% Offerload => Total channel throughput = 33.1883

80% Offerload => Total channel throughput = 34.8739

90% Offerload => Total channel throughput = 36.3711
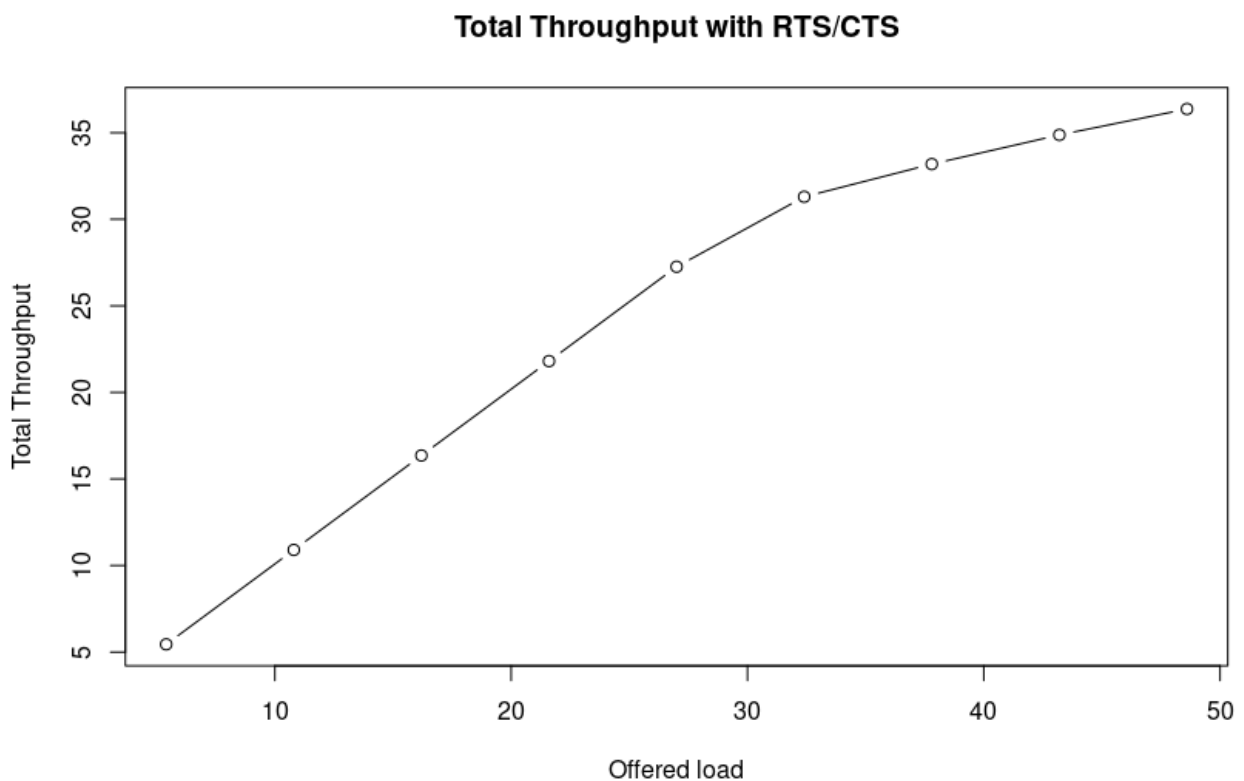
Total Throughput with RTS/CTS

10% Offerload => Total channel throughput = 1.81805

20% Offerload => Total channel throughput = 3.63864

30% Offerload => Total channel throughput = 5.45924

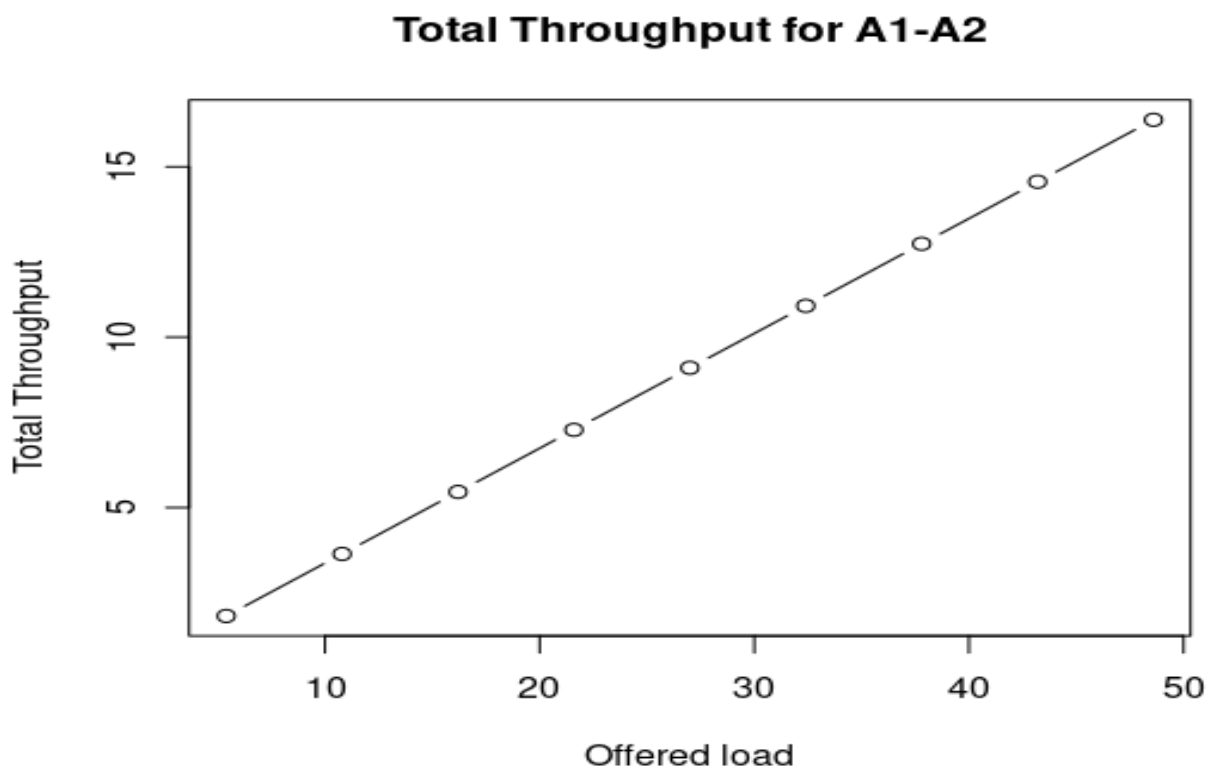40% Offerload => Total channel throughput = 7.27983

50% Offerload => Total channel throughput = 9.10043

60% Offerload => Total channel throughput = 10.9185

70% Offerload => Total channel throughput = 12.7391

80% Offerload => Total channel throughput = 14.5597

90% Offerload => Total channel throughput = 16.3777

Total Throughput for A1-A2

A1-A2 With RTS/CTS

10% Offerload => Total channel throughput = 1.8155

20% Offerload => Total channel throughput = 3.63355

30% Offerload => Total channel throughput = 5.4516

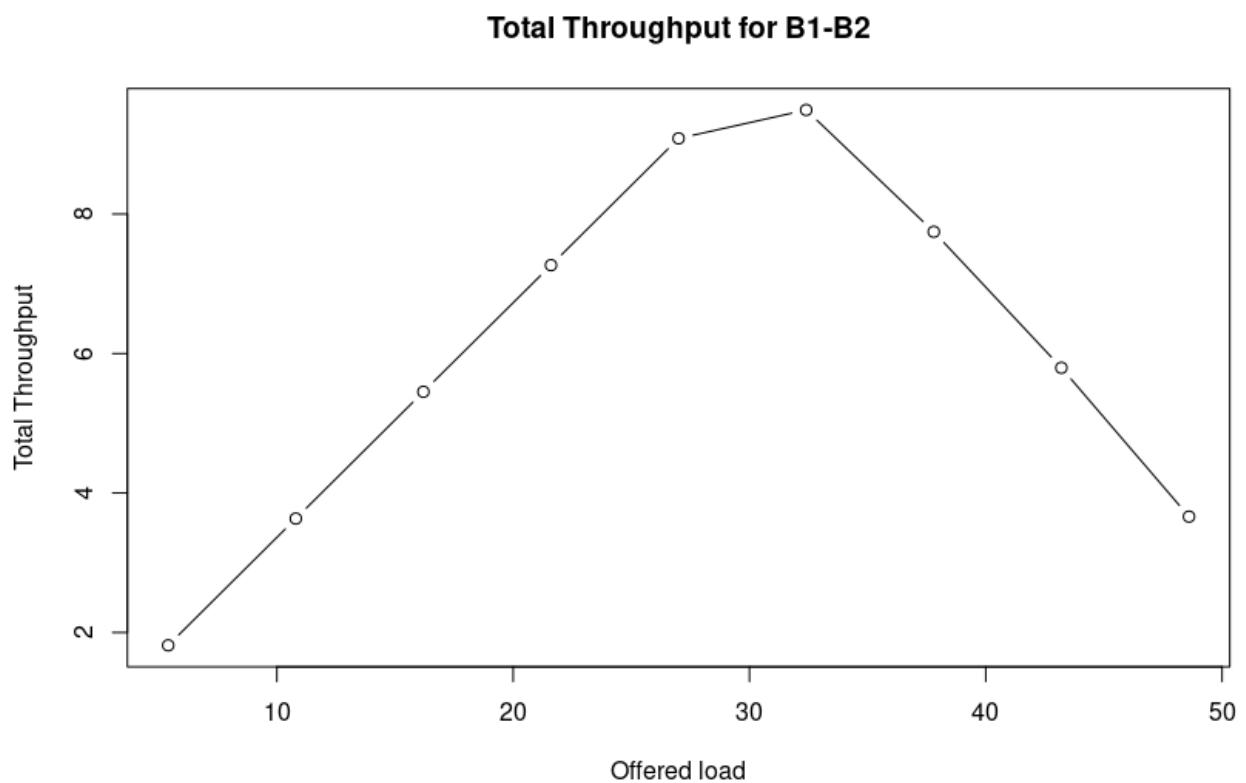40% Offerload => Total channel throughput = 7.2671

50% Offerload => Total channel throughput = 9.08515

60% Offerload => Total channel throughput = 9.49255

70% Offerload => Total channel throughput = 7.7458

80% Offerload => Total channel throughput = 5.79535

90% Offerload => Total channel throughput = 3.66156

Total Throughput for B1-B2

C1-C2 With RTS/CTS

10% Offerload => Total channel throughput = 1.81296

20% Offerload => Total channel throughput = 3.62846

30% Offerload => Total channel throughput = 5.44396

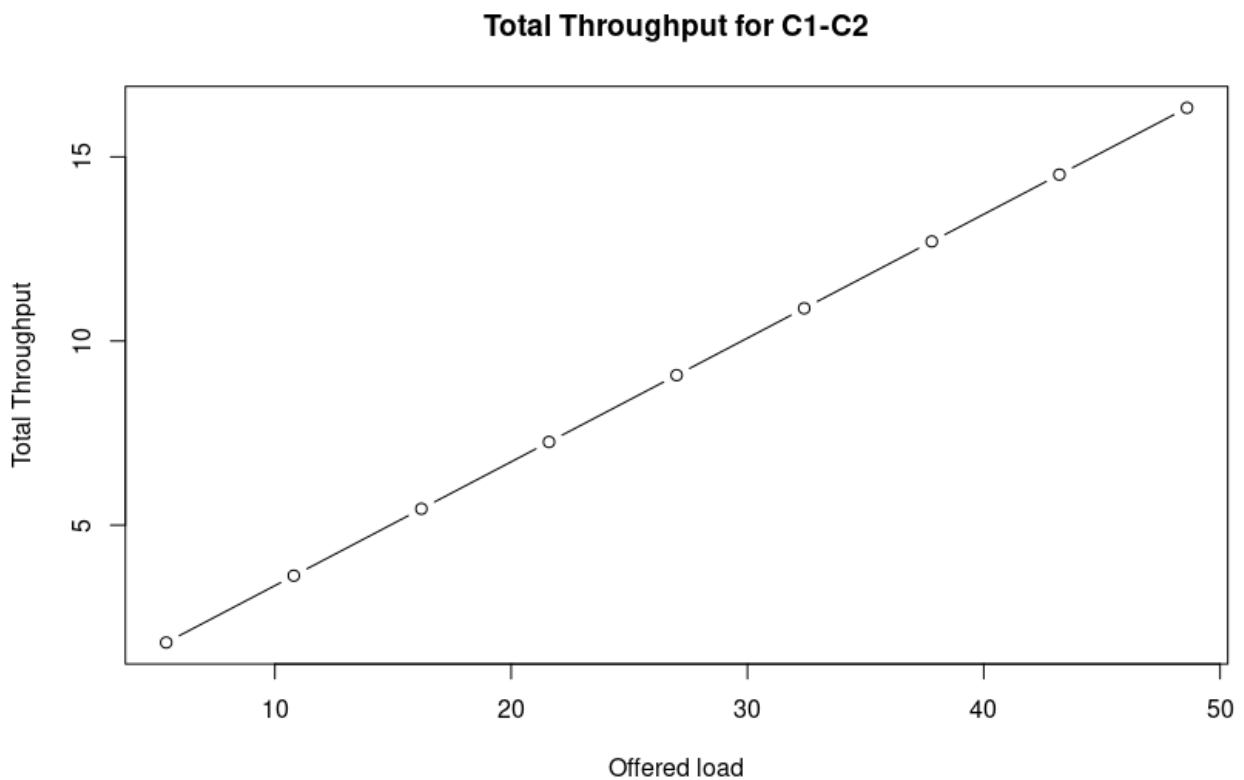40% Offerload => Total channel throughput = 7.25946

50% Offerload => Total channel throughput = 9.07242

60% Offerload => Total channel throughput = 10.8879

70% Offerload => Total channel throughput = 12.7034

80% Offerload => Total channel throughput = 14.5189

90% Offerload => Total channel throughput = 16.3319

Total Throughput for C1-C2

c)

Per Node Throughput of Node B1 and B2 is smallest

i.e., Flow(B1->B2) has smallest Throughput

Reason :-

CASE I:

A1, B1, C1 start transmission at the same time.

So, collision will occur and everyone will back-off

and random time will be alloted to start again.

CASE II:

A1 starts transmission, means A1 will send the RTS,

which is reachable to A2,B1 and B2.

So they(B1-B2) will definitely remain silent,

for the whole duration, but C1 can transmit easily(if has data to send)

because neither Carrier Sense A1 or A2.

So C1-C2 transmission can start anytime between A1-A2 transmission

and B1 and B2 will remain silent again.

CASE III:

B1 starts transmission, means B1 will send the RTS,

which is reachable to A1,A2,B2,C1 and C2.

So all 4 (A and C) will remain silent

and B will transmit without any interruption.

CASE IV:

C1 starts transmission, means C1 will send the RTS,

which is reachable to B1, B2 and C2.

So B1 and B2 will remain silent

and the rest part is the same as A1-A2 transmission (as A1-A2 transmission is allowed)

Here we can see that,

A1-A2 transmission is TOTALLY identical to

C1-C2 transmission and B1-B2 are different.

Now CASE I is of no-transmission.

For the rest of the cases we can see that if A transmits, C can transmit too and VICE-VERSA.

But if B's transmission happens then A and C will be silent.

Case II and IV allow A and C respectively (but also C and A respectively as we have seen).

But B will transmit only in CASE III.

Also Random back-off that tells which node to transmit first is also **equally likely**.

So A, B, C stands same there but after that B will have restrictions over it by A and C. So finally, we can state the data throughput as

$$(Ta = Tc > Tb)$$

This is the theortical observation, practical answer is close to it though not exact same because of finite no. of packet size of may be because of finite time.

Part B observation

As we keep increasing Offerload, Throughput will increase but after a certain value when we have to send too much data it will lead to long waiting time. Also A1-A2 and C1-C2 transmission can go on simultaniously, but both these require B1-B2 to be silent and hence after a certain offerload, we are observing a down slope in B1-B2 graph.

Question 4

a)
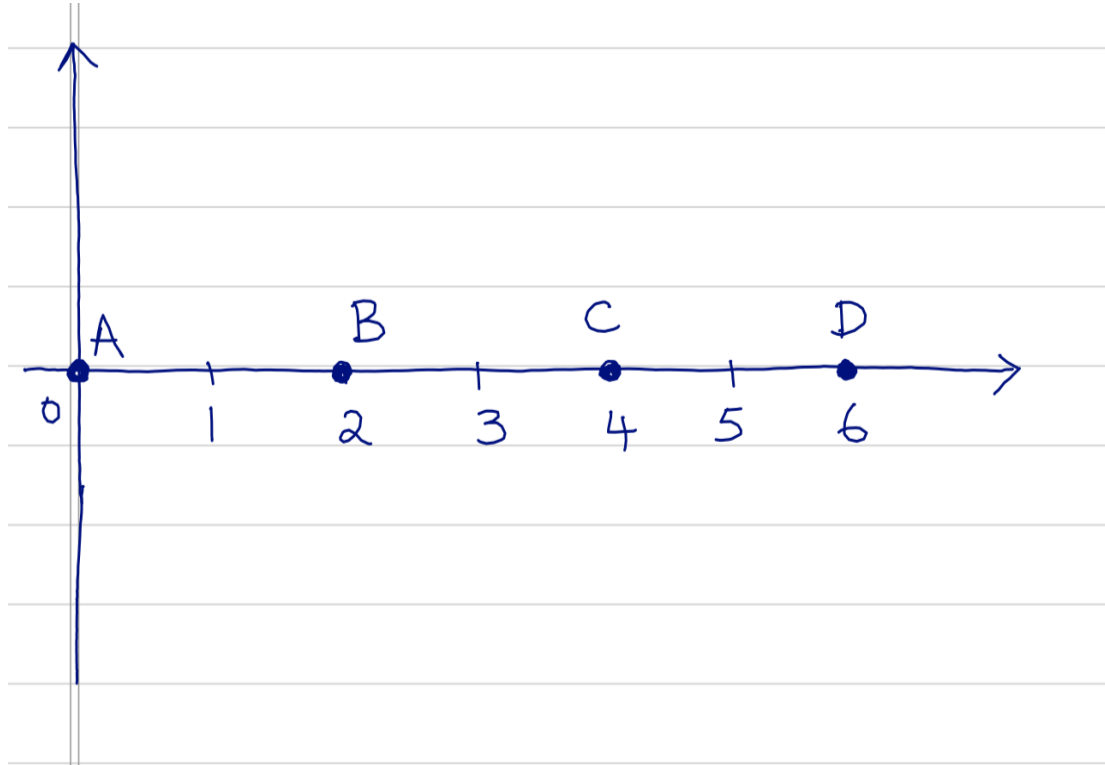
With RTS/CTS:

Per Node througput for node 0 = 8.80506

Per Node througput for node 1 = 8.80506

Per Node througput for node 2 = 10.0909

Per Node througput for node 3 = 10.0909

Total channel throughput = 18.896

b)

With RTS/CTS

10% Offerload => Total channel throughput = 5.45414

20% Offerload => Total channel throughput = 10.9108

30% Offerload => Total channel throughput = 16.365

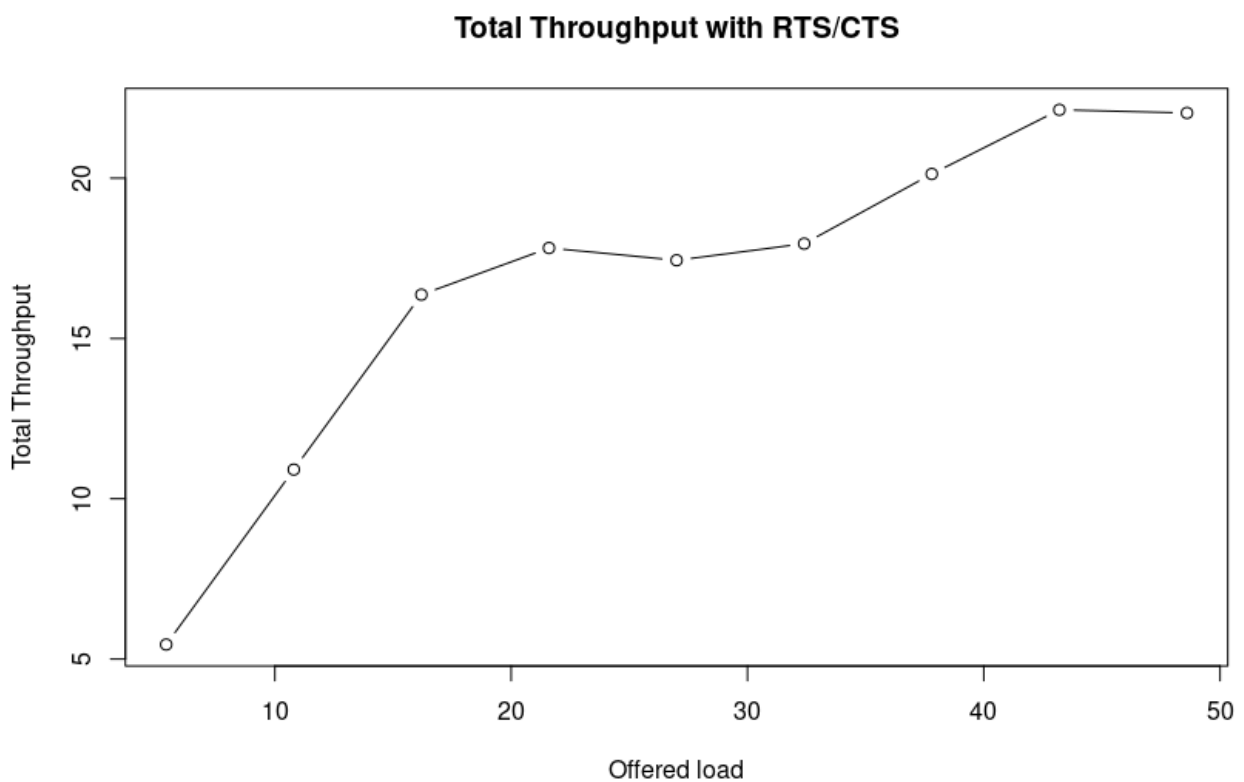40% Offerload => Total channel throughput = 17.8215

50% Offerload => Total channel throughput = 17.4319

60% Offerload => Total channel throughput = 17.9564

70% Offerload => Total channel throughput = 20.1309

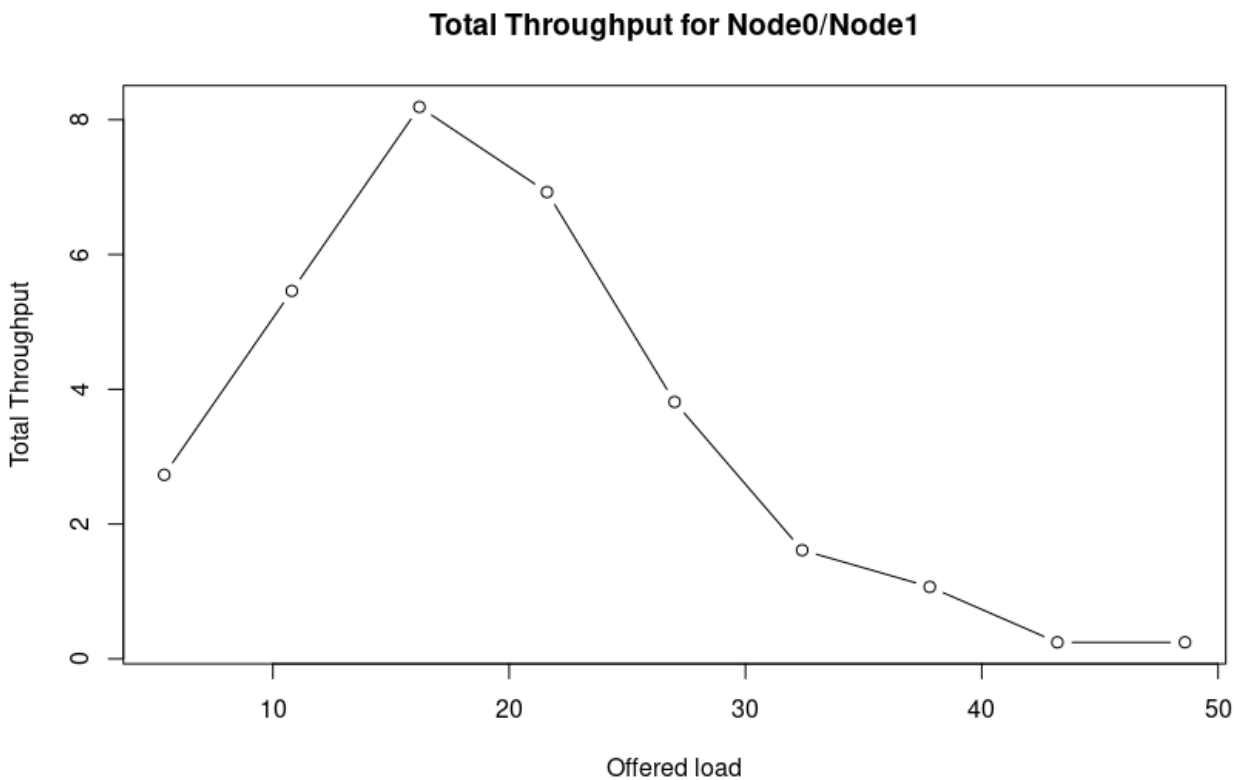80% Offerload => Total channel throughput = 22.033

90% Offerload => Total channel throughput = 22.033

Total Throughput with RTS/CTS

Node0/Node1 With RTS/CTS

10% Offerload => Total channel throughput = 2.72962

20% Offerload => Total channel throughput = 5.45924

30% Offerload => Total channel throughput = 8.18885

40% Offerload => Total channel throughput = 6.9259

50% Offerload => Total channel throughput = 3.81179

60% Offerload => Total channel throughput = 1.6118

70% Offerload => Total channel throughput = 1.06689

80% Offerload => Total channel throughput = 0.244443

90% Offerload => Total channel throughput = 0.244443

Total Throughput for Node0/Node1

Node2/Node3 With RTS/CTS

10% Offerload => Total channel throughput = 2.72453

20% Offerload => Total channel throughput = 5.4516

30% Offerload => Total channel throughput = 8.17612
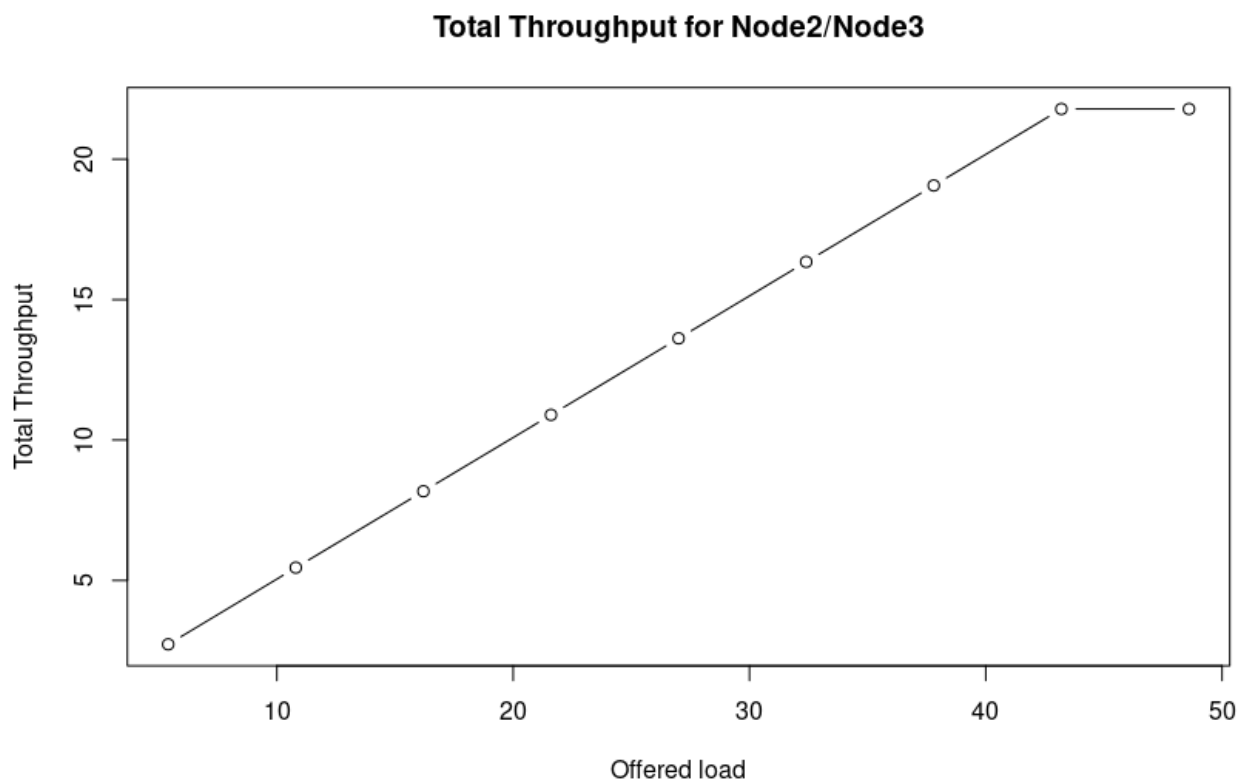
40% Offerload => Total channel throughput = 10.8956

50% Offerload => Total channel throughput = 13.6201

60% Offerload => Total channel throughput = 16.3446

70% Offerload => Total channel throughput = 19.064

80% Offerload => Total channel throughput = 21.7886

90% Offerload => Total channel throughput = 21.7886

Total Throughput for Node2/Node3

c)

First assume nothing is going on

CASE I

A & C both send RTS at the same time.

Collision will occur at B and no CTS will be there.

Now Random Back-off and again start from the same thing.

CASE II

A sent RTS first and C was silent.

Now B will send the CTS back and C will listen it and now has to wait for the NAV mentioned in it.

CASE III

C send RTS first and A was silent.

B will listen to the RTS of C and now has to remain silent for the NAV mentioned in it. But A will not listen the RTS of C nor the CTS of D. So, A will send the RTS now to B to send the Data. But since NAV time is not over yet, B will remain silent and will not send any CTS back.

Now, Case II, will become Case I if during the time when A was sending RTS, C also send his RTS (cannot do Carrier Sense).

But Case II will never become Case I because it doesn't matter if A want to send or not if B has listened to RTS of C first it will ignore A's RTS for all the NAV time.

Hense even if A want to send the Data or has sent the RTS, chances are that transmission will not be successful. But once C has sent the RTS, transmission will be successful.

Hence, Throughput of C-D will be greater then Throughput of A-B.

Part B observation

Now after knowing the reason for Throughput difference in the two flows that are going on. We can explain two graphs here as follows.

Since we keep increasing offerload, Throughput will increase. But when try to send too much data, i.e., we are requesting from A-B transmission to hold for more till C-D is going on. So this gap will widen and after a point the A-B throughput will start decreasing.

And hence the gaussian kinda nature of A-B and Straight line kinda nature for C-D.