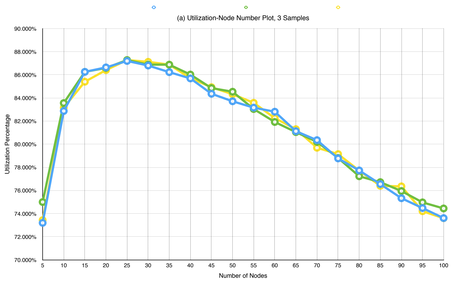
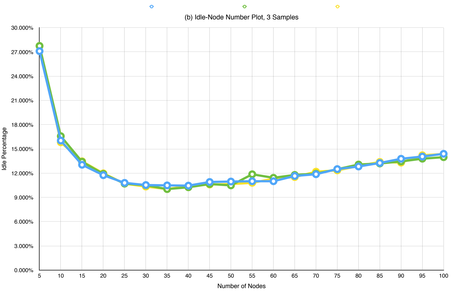
# Report

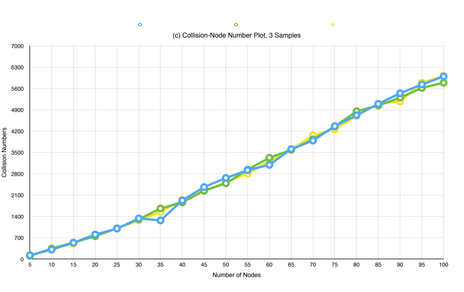
| Number of Node | Utilization (3 samples) | | | Idle (3 samples) | | | collision (3 samples) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| 5 | 73.200% | 75.000% | 73.438% | 27.100% | 27.744% | 27.744% | 130 | 108 | 108 |
| 10 | 82.870% | 83.558% | 83.160% | 16.032% | 16.574% | 15.818% | 313 | 350 | 331 |
| 15 | 86.254% | 86.254% | 85.400% | 13.036% | 13.408% | 13.466% | 540 | 545 | 515 |
| 20 | 86.638% | 86.590% | 86.404% | 11.746% | 11.904% | 11.978% | 808 | 753 | 810 |
| 25 | 87.196% | 87.274% | 87.274% | 10.796% | 10.704% | 10.704% | 1004 | 1011 | 1011 |
| 30 | 86.800% | 86.880% | 87.120% | 10.526% | 10.498% | 10.338% | 1337 | 1311 | 1271 |
| 35 | 86.228% | 86.876% | 86.876% | 10.484% | 10.028% | 10.028% | 1271 | 1664 | 1548 |
| 40 | 85.686% | 86.020% | 85.710% | 10.454% | 10.252% | 10.406% | 1930 | 1864 | 1942 |
| 45 | 84.360% | 84.850% | 84.926% | 10.956% | 10.652% | 10.592% | 2387 | 2249 | 2241 |
| 50 | 83.710% | 84.536% | 84.320% | 10.960% | 10.486% | 10.644% | 2665 | 2489 | 2518 |
| 55 | 83.160% | 83.040% | 83.580% | 11.000% | 11.860% | 10.804% | 2920 | 2937 | 2808 |
| 60 | 82.808% | 81.920% | 82.256% | 11.000% | 11.422% | 11.312% | 3096 | 3329 | 3216 |
| 65 | 81.126% | 81.046% | 81.298% | 11.650% | 11.778% | 11.518% | 3612 | 3588 | 3592 |
| 70 | 80.350% | 80.198% | 79.692% | 11.866% | 11.936% | 12.180% | 3892 | 3933 | 4064 |
| 75 | 78.770% | 78.808% | 79.144% | 12.500% | 12.490% | 12.340% | 4365 | 4351 | 4258 |
| 80 | 77.732% | 77.228% | 77.716% | 12.824% | 13.066% | 12.886% | 4722 | 4853 | 4699 |
| 85 | 76.550% | 76.720% | 76.400% | 13.258% | 13.196% | 13.388% | 5096 | 5042 | 5106 |
| 90 | 75.530% | 75.950% | 76.354% | 13.778% | 13.450% | 13.302% | 5446 | 5300 | 5172 |
| 95 | 74.480% | 74.972% | 74.206% | 14.054% | 13.788% | 14.210% | 5733 | 5620 | 5792 |
| 100 | 73.612% | 74.446% | 73.602% | 14.392% | 13.976% | 14.370% | 5998 | 5789 | 6014 |

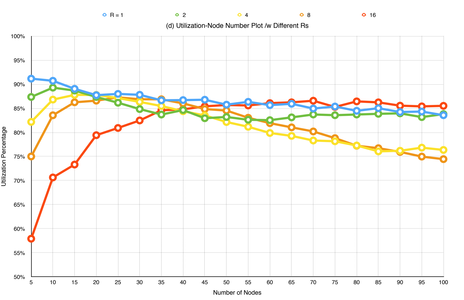
| Number of Node | Utilization | | | | |
|---|---|---|---|---|---|
| | R = 1 | 2 | 4 | 8 | 16 |
| 5 | 91.164% | 87.357% | 82.18% | 75.000% | 57.92% |
| 10 | 90.718% | 89.294% | 86.812% | 83.558% | 70.64% |
| 15 | 89.052% | 88.69% | 87.792% | 86.254% | 73.32% |
| 20 | 87.732% | 87.354% | 87.784% | 86.590% | 79.416% |
| 25 | 87.994% | 86.166% | 87.12% | 87.274% | 80.92% |
| 30 | 87.81% | 84.84% | 86.334% | 86.880% | 82.48% |
| 35 | 86.662% | 83.706% | 85.48% | 86.876% | 84.594% |
| 40 | 86.708% | 84.64% | 84.392% | 86.020% | 84.79% |
| 45 | 86.782% | 82.944% | 83.532% | 84.850% | 85.414% |
| 50 | 85.756% | 83.206% | 82.16% | 84.536% | 85.694% |
| 55 | 86.346% | 82.62% | 81.168% | 83.040% | 85.592% |
| 60 | 85.662% | 82.54% | 79.88% | 81.920% | 86.08% |
| 65 | 85.938% | 83.12% | 79.276% | 81.046% | 86.244% |
| 70 | 84.958% | 83.72% | 78.314% | 80.198% | 86.578% |
| 75 | 85.376% | 83.574% | 78.16% | 78.808% | 85.28% |
| 80 | 84.486% | 83.716% | 77.228% | 77.228% | 86.44% |
| 85 | 85.025% | 83.858% | 76.06% | 76.720% | 86.24% |
| 90 | 84.231% | 83.956% | 76.184% | 75.950% | 85.55% |
| 95 | 84.331% | 83.176% | 76.832% | 74.972% | 85.406% |
| 100 | 83.57% | 83.804% | 76.354% | 74.446% | 85.516% |

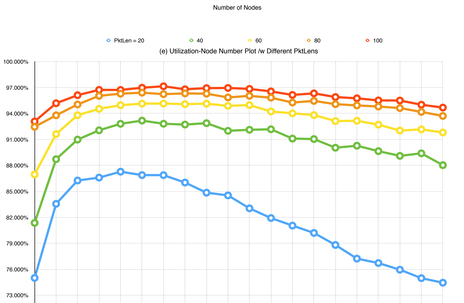
| Number of Node | Utilization | | | | |
|---|---|---|---|---|---|
| | PktLen = 20 | 40 | 60 | 80 | 100 |
| 5 | 75.000% | 81.36% | 86.96% | 92.454% | 93.08% |
| 10 | 83.558% | 88.72% | 91.626% | 93.79% | 95.18% |
| 15 | 86.254% | 90.982% | 93.798% | 95.04% | 96.112% |
| 20 | 86.590% | 92.056% | 94.54% | 96.04% | 96.728% |
| 25 | 87.274% | 92.808% | 94.958% | 96.286% | 96.716% |
| 30 | 86.880% | 93.174% | 95.136% | 96.404% | 96.974% |
| 35 | 86.876% | 92.814% | 95.146% | 96.232% | 97.144% |
| 40 | 86.020% | 92.72% | 95.078% | 96.318% | 96.794% |
| 45 | 84.850% | 92.88% | 95.134% | 96.286% | 96.928% |
| 50 | 84.536% | 91.996% | 94.88% | 95.854% | 96.95% |
| 55 | 83.040% | 92.116% | 94.998% | 96.038% | 96.84% |
| 60 | 81.920% | 92.174% | 94.234% | 95.826% | 96.548% |
| 65 | 81.046% | 91.098% | 94.018% | 95.262% | 96.142% |
| 70 | 80.198% | 91.044% | 93.814% | 95.452% | 96.324% |
| 75 | 78.808% | 90.042% | 93.124% | 95.076% | 95.899% |
| 80 | 77.228% | 90.276% | 93.156% | 94.932% | 95.752% |
| 85 | 76.720% | 89.648% | 92.708% | 94.804% | 95.512% |
| 90 | 75.950% | 89.102% | 92.030% | 94.622% | 95.498% |
| 95 | 74.972% | 89.396% | 92.16% | 94.18% | 95.011% |
| 100 | 74.446% | 88.03% | 91.804% | 93.716% | 94.68% |




(f)

In (d), initial R value affect the scenarios whose node numbers are small. When there is a big R value, e.g. 16 with a node number of 5, nodes would pick a inefficient random number to start with. Then time is wasted in counting down while no node is transmitting. R value's effect vanishes when the number of nodes grows, because there are enough nodes to fill up the whole range between 0 and R so that each random number picked has a node to transmit.

In (e), it is obvious that the long the packet the higher the utilization ratio is. Longer packet reduce the time of deciding which node is going to transfer. Mathematically, for 20 pktlen, in 50,000 ticks, there are 2,500 times where we have to decide which node is transmitting. This means there are 2,500 times for collision to happen. But if pktlen is 100, this number is 500. Then collision is less likely to happen. Thus channel is used more efficiently.

In both (d) and (e), it is observed that 30-40 nodes would give the maximum of utilization where there are enough nodes want to transfer while not too many nodes to collide with each other.