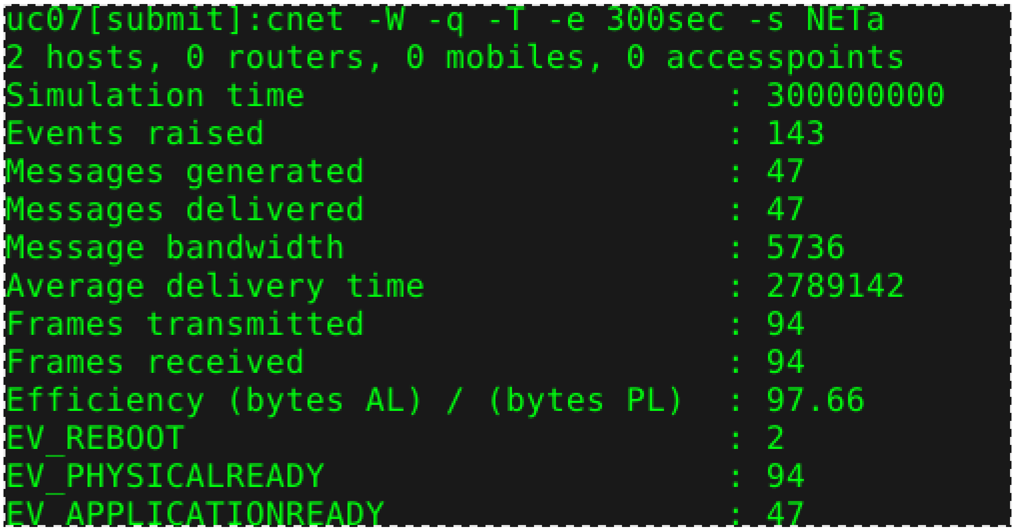
```
/*
	CMPUT 313
	Lab #2
	Wei Song
	1413835
*/
```

Part 1:

1.

NETa:

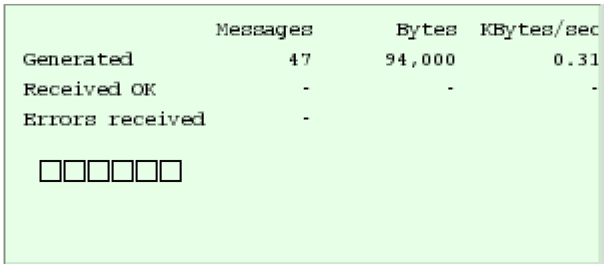
Global



```
uc07[submit]:cnet -W -q -T -e 300sec -s NETa
2 hosts, 0 routers, 0 mobiles, 0 accesspoints
Simulation time                      : 300000000
Events raised                        : 143
Messages generated                   : 47
Messages delivered                   : 47
Message bandwidth                    : 5736
Average delivery time                : 2789142
Frames transmitted                   : 94
Frames received                      : 94
Efficiency (bytes AL) / (bytes PL)   : 97.66
EV_REBOOT                            : 2
EV_PHYSICALREADY                     : 94
EV_APPLICATIONREADY                  : 47
```

Per-node

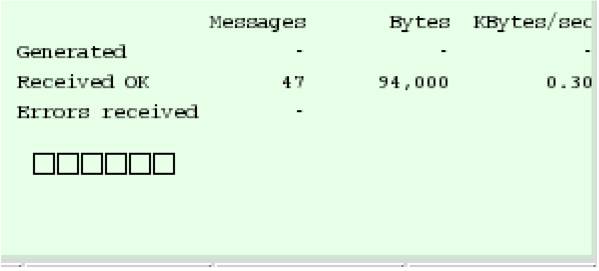
Perth



```
                       Messages        Bytes   KBytes/sec
  Generated                  47       94,000         0.31
  Received OK                 -            -            -
  Errors received             -

    □□□□□□
```

Sydney

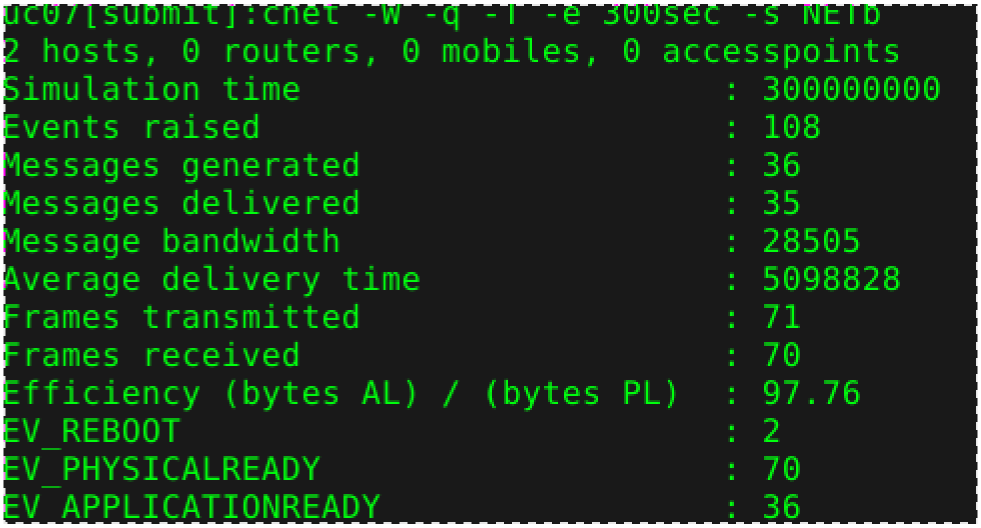


```
                       Messages        Bytes   KBytes/sec
  Generated                   -            -            -
  Received OK                47       94,000         0.30
  Errors received             -

    □□□□□□
```

NETb:

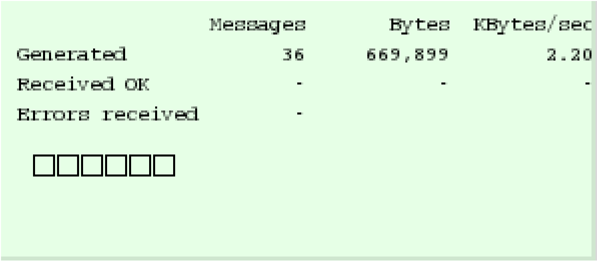
Global



```
uc07[submit]:cnet -W -q -T -e 300sec -s NETb
2 hosts, 0 routers, 0 mobiles, 0 accesspoints
Simulation time                     : 300000000
Events raised                       : 108
Messages generated                  : 36
Messages delivered                  : 35
Message bandwidth                   : 28505
Average delivery time               : 5098828
Frames transmitted                  : 71
Frames received                     : 70
Efficiency (bytes AL) / (bytes PL)  : 97.76
EV_REBOOT                           : 2
EV_PHYSICALREADY                    : 70
EV_APPLICATIONREADY                 : 36
```

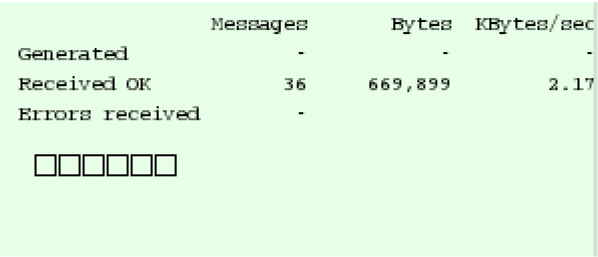
Per_node

Perth



```
                    Messages       Bytes  KBytes/sec
Generated                 36     669,899        2.20
Received OK                -           -           -
Errors received            -
```

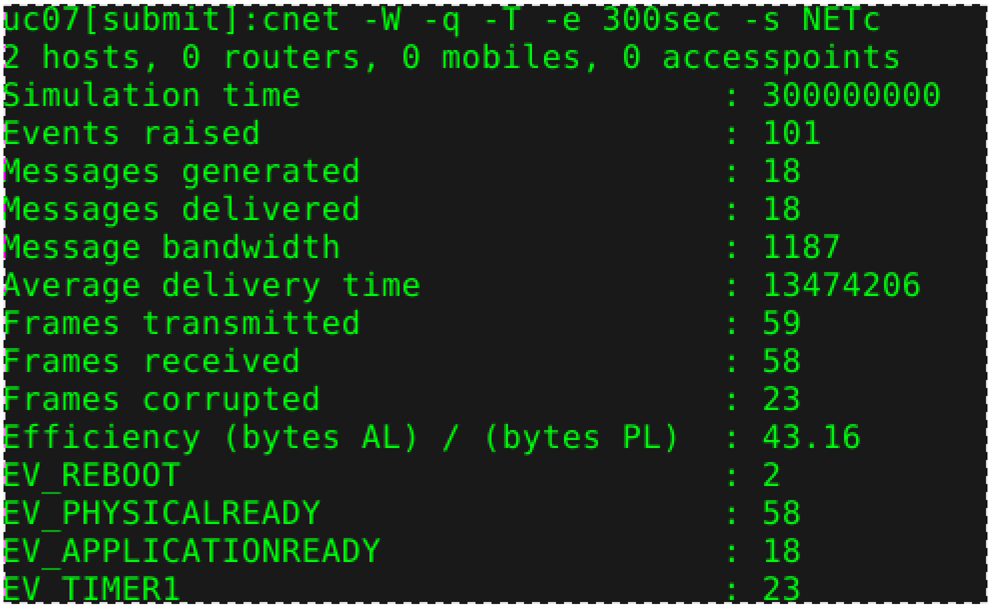
Sydney



```
                    Messages       Bytes  KBytes/sec
Generated                  -           -           -
Received OK               36     669,899        2.17
Errors received            -
```

NETc:

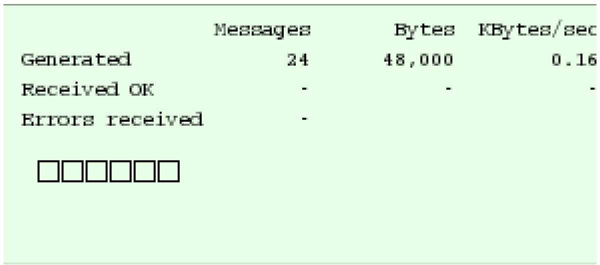
Global



```
uc07[submit]:cnet -W -q -T -e 300sec -s NETc
2 hosts, 0 routers, 0 mobiles, 0 accesspoints
Simulation time                     : 300000000
Events raised                       : 101
Messages generated                  : 18
Messages delivered                  : 18
Message bandwidth                   : 1187
Average delivery time               : 13474206
Frames transmitted                  : 59
Frames received                     : 58
Frames corrupted                    : 23
Efficiency (bytes AL) / (bytes PL)  : 43.16
EV_REBOOT                           : 2
EV_PHYSICALREADY                    : 58
EV_APPLICATIONREADY                 : 18
EV_TIMER1                           : 23
```

Per-node

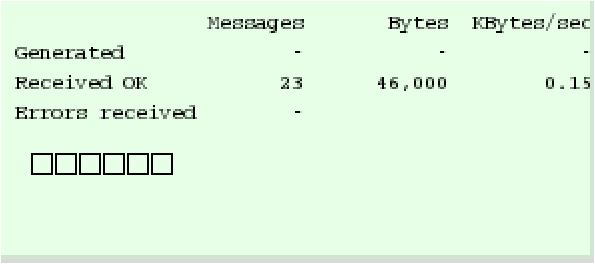
Perth



```
                      Messages       Bytes  KBytes/sec
Generated                   24      48,000        0.16
Received OK                  -           -           -
Errors received              -
```

□□□□□□

Sydney

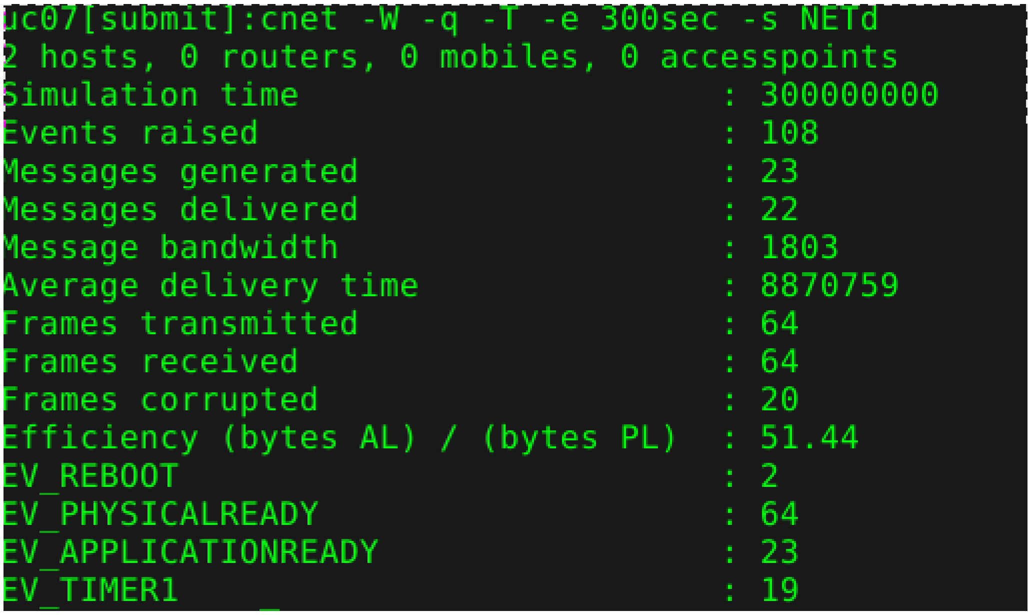


```
                      Messages       Bytes  KBytes/sec
Generated                    -           -           -
Received OK                 23      46,000        0.15
Errors received              -
```

□□□□□□

NETd:

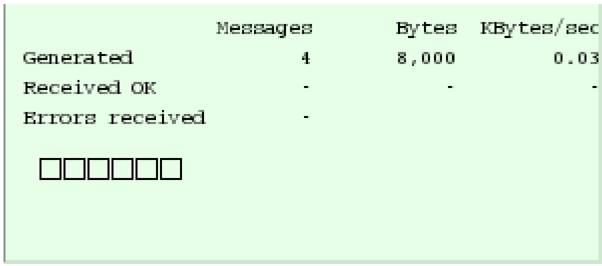
Global



```
uc07[submit]:cnet -W -q -T -e 300sec -s NETd
2 hosts, 0 routers, 0 mobiles, 0 accesspoints
Simulation time                     : 300000000
Events raised                       : 108
Messages generated                  : 23
Messages delivered                  : 22
Message bandwidth                   : 1803
Average delivery time               : 8870759
Frames transmitted                  : 64
Frames received                     : 64
Frames corrupted                    : 20
Efficiency (bytes AL) / (bytes PL)  : 51.44
EV_REBOOT                           : 2
EV_PHYSICALREADY                    : 64
EV_APPLICATIONREADY                 : 23
EV_TIMER1                           : 19
```

Per-node

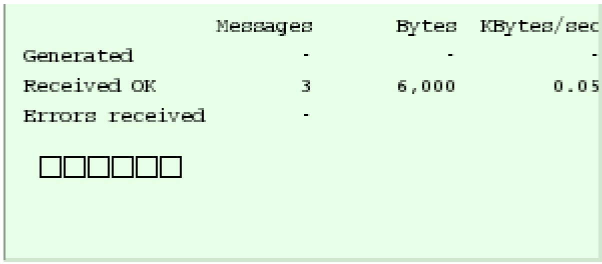
Perth



```
                     Messages      Bytes  KBytes/sec
Generated                   4      8,000        0.03
Received OK                 -          -           -
Errors received             -

 □□□□□□
```

Sydney



```
                     Messages      Bytes  KBytes/sec
Generated                   -          -           -
Received OK                 3      6,000        0.05
Errors received             -

 □□□□□□
```

2. Mathematical Modelling

Assumption:
Round Trip Time: RTT
Size of a packet: L
Transmission Rate: R
Transmission time of a packet: Tpkt
Message Rate: Rmess
Propagation Delay: Tprop

Given values:
R = 56 Kbps
L = 2000 bytes
Rmess = 1 sec = 1000 ms
Tprop = 2.5sec = 2500 ms

Common Calculations:

Tpkt = L/R
= 2000 bytes/ 56 Kbps
= 0.2857 s

RTT = 2*(Tprop) + Rmess
= 2*2500 ms + 1000 ms
= 6000 ms

NETa:
In NETa, there is no error generation. It will be the Thr_error-free.
Thr_error-free = 1/(Tpkt + RTT)* 2KB/pkt = 0.32 KBytes/sec
Thr_mess = 1/(Tpkt + RTT) = 0.16 message/sec

NETb:
In NETb, there is no error generation. It will also be the Thr_error-free.
L-min = 2000 bytes
L-max = 8000 bytes
Since it is a random variable, L = (L-min+L-max)/2
L = (8000+2000)/2 = 5000 bytes
Tpkt = L/R = 5000 bytes/ 56 Kbps = 0.0893 sec
Thr_error-free = 1/(Tpkt + RTT)*5KB/pkt = 0.68 Kbytes/sec
Thr-mess = 0.13 message/sec

NETc:
In NETc, there is error generation.
Thr_error-free = 1/(Tpkt + RTT) = 0.1590 pkt/sec
Thr = 1/(1-framecorruptProb) * 2KB/pkt
= 0.1590/(1/(1-0.5)) * 2KB/pkt
= 0.16 KBytes/sec
Thr-mess = 0.0795 message/sec

NETd:
In NETd, both data and ACK frames corrupt with probability 0.5 each.
Assumption:
D – data corrupt probability = 0.5
A – ACK corrupt probability = 0.5
Nr = 1/(((1-0.5)*(1-0.5))*((1-0.5)*(1-0.5)))
= 16
Thr = (Thr_error-free/Nr)*2KB/pkt
= (0.1590/16)*2KB/pkt
= 0.019 Kbytes/sec
Thr-mess = 0.00993 = 0.01 message/sec

3. Analysis of cnet Simulation Results

NETa:

Expected: Thr-data = 0.32KB/sec   Thr-mess = 0.16 message/sec
Experimental: Thr-data = 0.31KB/sec   Thr-mess = 47mes/300s=0.16message/s
Data Error percent = ((0.31-0.32)/0.32)*100% = 3.1%
Message Error percent = ((0.16-0.16)/0.16)*100% = 0%

Since both data and message error percent is in a very small value, it means the calculations are both correct.

NETb:

Expected: Thr-data = 0.68KB/sec   Thr-mess = 0.13 message/sec
Experimental: Thr-data = 0.22KB/sec   Thr-mess = 36mes/300s=0.12message/s
Data Error percent = ((0.22-0.68)/0.68)*100% = 67.65%
Message Error percent = ((0.12-0.13)/0.13) * 100% = 7.69%

The message error percent is accepted because it is under 10% with the expected. For data error percent, it has 67.65% difference. But as the problem states, the length of an application layer message is a uniform random variable with value between 2000 bytes and the default maximum length. So we expected the error percent is close to 50%. It is correct.

NETc:

Expected: Thr-data = 0.16KB/sec   Thr-mess = 0.0795 message/sec
Experimental: Thr-data = 0.22KB/sec   Thr-mess = 22mes/300s=0.073mess/s
Data Error percent = ((0.22-0.16)/0.16)*100% = 37.5%
Message Error percent = ((0.073-0.0795)/0.0795)*100% = 8.18%

The message error percent is low which means it is correct. For data error, it has a large difference with the expected value. The reason causes this is the physical layer corrupts data frames with probability 0.5.

NETd:

Expected: Thr-data = 0.019KB/sec   Thr-mess = 0.01 message/sec
Experimental: Thr-data = 0.03KB/sec   Thr-mess = 4mes/300s=0.013mess/s
Data Error percent = ((0.03-0.019)/0.019)*100% = 57.9%
Message Error percent = ((0.013-0.01)/0.01)*100% = 30%

Both data and message error have a significant difference with the expected. The reason cause this is both data and ACK frames with probability 0.5 each. The randomness is the reason. If run longer time, the percent will decrease.

4. Discussion

In these four scenarios, each of the NET has some commonalities and differences between the analytical results and the simulation results.

For the scenario that no packets or data loss and corrupt. The results between the analytical results and the simulation results should always be close, like the NETa. The reason is the every time the packet and ACK receive correctly and no exceptions.

No packets or data loss and corrupt is the perfect scenario. Mostly, there is packets or data loss or corrupt in the real testing. In NETb, NETc and NETd, there is either data or packets loss or corrupt. Therefore, the analytical results and the simulation results will not always be the same. The testing time in this lab is around 300sec. It is a short time for a uniform random variable to get the reliable results. Since it is random, the difference of the results between the analytical results and the simulation results should be large in the short run. In my opinion, to make the results more reliable, we should extend the testing time. The longer the testing time, the results will close to a constant value which I think it should be the analytical results.

In conclusion, the reason causes the difference between the analytical results and the simulation results is how long the simulation testing time is. As the time goes by, the simulation results should be close to the analytical results.