CIS549 – Project 5

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Problem 1:

From the throughput chart, we can see that each UE obtains roughly equal throughput with total throughput being equal to the sum of all 3 UEs.

A screenshot of a social media post

Description automatically generated

From the download stats file, we can validate some of the entries:

time celId IMSI frame sfrm RNTI mcsTb size1 mcs2 sz2 Nprb

1.551 1 3 156 2 1 5 1095 0 0 98

1.624 1 2 163 5 3 25 7167 0 0 98

1.625 1 2 163 6 3 20 4904 0 0 98

1.626 1 2 163 7 3 20 4904 0 0 98

1.627 1 1 163 8 2 15 3542 0 0 97

1.628 1 1 163 9 2 15 3542 0 0 97

1.629 1 1 163 10 2 15 3542 0 0 97

1.63 1 1 164 1 2 10 1980 0 0 99

1.631 1 1 164 2 2 10 1980 0 0 99

For instance, we take the frame ID (minus 1 because the subframes start with 1 in the file, but in our program they start with 0) and add to the subframe (minus 1 because the subframes are listed as 1-10, but in our program, they are 0-9). So, Frame 163, subframe 10 is row 1629 in our validation sheet and Frame 164, subframe 1 is row 1630. For IMSI=1 (came from the UE2.txt parameter file), we can see the MCS value change from 15 to 10. Below is a subset of our validation spreadsheet. It shows that we can expect the MCS value to change from 15 to 10.

|  |  |  |  |
| --- | --- | --- | --- |
| frame | UE1(3) MCS | UE2(1) MCS | UE3(2) MCS |
| 1623 | 5 | 15 | 25 |
| 1624 | 1 | 10 | 20 |
| 1625 | 5 | 15 | 25 |
| 1626 | 1 | 10 | 20 |
| 1627 | 5 | 15 | 25 |
| 1628 | 1 | 10 | 20 |
| 1629 | 5 | 15 | 25 |
| 1630 | 1 | 10 | 20 |
| 1631 | 5 | 15 | 25 |
| 1632 | 1 | 10 | 20 |
| 1633 | 5 | 15 | 25 |

Let’s take another example for IMSI=3 (came from the UE1.txt parameter file):

time celId IMSI frame sfrm RNTI mcsTb size1 mcs2 sz2 Nprb

1.042 1 3 105 3 1 5 349 0 0 32

1.042 1 1 105 3 2 10 645 0 0 32

1.042 1 2 105 3 3 20 1572 0 0 32

1.139 1 1 114 10 2 10 645 0 0 32

1.139 1 2 114 10 3 20 1572 0 0 32

1.139 1 3 114 10 1 1 145 0 0 32

1.14 1 3 115 1 1 1 217 0 0 47

1.14 1 1 115 1 2 10 935 0 0 47

1.141 1 3 115 2 1 1 453 0 0 98

1.142 1 3 115 3 1 1 453 0 0 98

1.143 1 3 115 4 1 5 1095 0 0 98

1.236 1 2 124 7 3 20 4904 0 0 98

1.237 1 1 124 8 2 10 1980 0 0 99

1.238 1 1 124 9 2 10 1980 0 0 99

Here you can see Frame 115, subframe 3 (row 1142 in the validation sheet) and Frame 115, subframe 4 (row 1143). The MCS value changes from 5 to 1, which is what we see in the validation sheet:

|  |  |  |  |
| --- | --- | --- | --- |
| frame | UE1(3) MCS | UE2(1) MCS | UE3(2) MCS |
| 1138 | 1 | 10 | 20 |
| 1139 | 5 | 15 | 25 |
| 1140 | 1 | 10 | 20 |
| 1141 | 5 | 15 | 25 |
| 1142 | 1 | 10 | 20 |
| 1143 | 5 | 15 | 25 |
| 1144 | 1 | 10 | 20 |
| 1145 | 5 | 15 | 25 |
| 1146 | 1 | 10 | 20 |
| 1147 | 5 | 15 | 25 |
| 1148 | 1 | 10 | 20 |

Final example for IMSI=2 (came from the UE3.txt parameter file):

time celId IMSI frame sfrm RNTI mcsTb size1 mcs2 sz2 Nprb

3.963 1 2 397 4 3 20 2385 0 0 48

3.964 1 2 397 5 3 20 2385 0 0 48

3.964 1 3 397 5 1 5 533 0 0 48

3.965 1 2 397 6 3 20 2385 0 0 48

3.965 1 3 397 6 1 1 217 0 0 47

3.966 1 3 397 7 1 1 217 0 0 47

3.966 1 2 397 7 3 20 2385 0 0 48

3.967 1 2 397 8 3 25 3422 0 0 47

3.967 1 3 397 8 1 1 217 0 0 47

3.968 1 2 397 9 3 25 3422 0 0 47

Here you can see Frame 397, subframe 7 (row 3966 in the validation sheet) and Frame 397, subframe 8 (row 3967). The MCS value changes from 20 to 25, which is what we see in the validation sheet:

|  |  |  |  |
| --- | --- | --- | --- |
| frame | UE1(3) MCS | UE2(1) MCS | UE3(2) MCS |
| 3963 | 5 | 15 | 25 |
| 3964 | 1 | 10 | 20 |
| 3965 | 5 | 15 | 25 |
| 3966 | 1 | 10 | 20 |
| 3967 | 5 | 15 | 25 |
| 3968 | 1 | 10 | 20 |
| 3969 | 5 | 15 | 25 |
| 3970 | 1 | 10 | 20 |

Problem 2

Flowchart:

A close up of a logo

Description automatically generated

Validation scenario used to generate Gnuplots:

./waf --run "scratch/prj5\_px --OutputFileName=output/prj --Scenario=3 --NumberUE=1 --Transport=1 --wifiMcs=HtMcs7 --tcpRcvBufBytes=1024000 --DataSizeforTCP=5000000 --DataRateforUDP=200Mb/s --delayValueforRHtoR=5 --delayValueforLte=50 --delayValueforWifi=10 --simTime=7 --aggPath=lteAndWifi --inOrderTimeout=100"

Scenario includes a dropped packet #100

Gnuplots:

We can see the delay is not greater than our timeout period of 100ms.

A screenshot of a social media post

Description automatically generated

We can see some of the packets are out of sequence when they are received by RecvQueue.

A picture containing screenshot

Description automatically generated

We can see the packets are all in order when sent to the upper layer.

A screenshot of a cell phone

Description automatically generated