

# HW2 GBN protocol

B06901061 電機三 王廷峻

## GBN Programming

(a) 20 0.1 0.1 10 2 (輸出所有 output log)

Log 輸出文字解釋

```
1  ## A (sender)
2  # output
3  A | send packet: [num]          # A sends a packet with seqnum = num
4  A | Current Base: [num]         # Current base is indexed as seqnum =
    num
5  A | Empty buffer, restart timer # base == nextSeqNum
6  A | window is full. Buffered [num] # Buffered packet with seqnum = num
7  # input
8  A | received corrupt ACK: [num]  # A received corrupt packet with
    seqnum = num
9  A | received ACK: [num]          # A received valid packet with seqnum
    = num
10 A | ACK is out of date: [num]    # A received a packet with seqnum =
    num < base
11 A | New base: [num]              # Update base
12 A | Empty buffer                # Termination
13
14 ## B (receiver)
15 # input
16 B | received corrupt packet: [num] # B received corrupt packet with
    seqnum = num
17 B | received out of order packet: [num] # num != Expected seqnum
18 B | received in order packet: [num] # num == Expected seqnum
19 B | send ACK: [num]              # B sends packet with acknum = num
```

```
1  ----- Stop and wait Network Simulator Version 1.1 -----
2
3  the number of messages to simulate: 20
4  packet loss probability: 0.100000
5  packet corruption probability: 0.100000
6  average time between messages from sender's layer5: 10.000000
7  TRACE: 2
8
9  EVENT time: 6.965711,  type: 1, fromlayer5  entity: 0
10 A | send packet: [1]
11 A | Current Base: [1]
```

```
12 A | Empty buffer, restart timer
13
14 EVENT time: 12.374607, type: 2, fromlayer3 entity: 1
15 B | received in order packet: [1]
16 B | send ACK: [1]
17
18 EVENT time: 17.132755, type: 2, fromlayer3 entity: 0
19 A | received ACK: [1]
20 A | New base: [2]
21 A | Empty buffer
22
23 EVENT time: 19.661861, type: 1, fromlayer5 entity: 0
24 A | send packet: [2]
25 A | Current Base: [2]
26 A | Empty buffer, restart timer
27
28 EVENT time: 28.642408, type: 1, fromlayer5 entity: 0
29 A | send packet: [3]
30 A | Current Base: [2]
31
32 EVENT time: 29.189991, type: 2, fromlayer3 entity: 1
33 B | received in order packet: [2]
34 B | send ACK: [2]
35
36 EVENT time: 31.887445, type: 1, fromlayer5 entity: 0
37 A | send packet: [4]
38 A | Current Base: [2]
39
40 EVENT time: 32.231213, type: 1, fromlayer5 entity: 0
41 A | send packet: [5]
42 A | Current Base: [2]
43 TOLAYER3: packet being lost
44
45 EVENT time: 37.491920, type: 2, fromlayer3 entity: 1
46 B | received in order packet: [3]
47 B | send ACK: [3]
48
49 EVENT time: 38.978420, type: 2, fromlayer3 entity: 0
50 A | received ACK: [2]
51 A | New base: [3]
52
53 EVENT time: 44.445282, type: 2, fromlayer3 entity: 1
54 B | received in order packet: [4]
55 B | send ACK: [4]
56
57 EVENT time: 46.495636, type: 2, fromlayer3 entity: 0
58 A | received ACK: [3]
59 A | New base: [4]
60
```

```
61  EVENT time: 51.620754,  type: 1, fromlayer5  entity: 0
62  A | send packet: [6]
63  A | Current Base: [4]
64
65  EVENT time: 52.102596,  type: 1, fromlayer5  entity: 0
66  A | send packet: [7]
67  A | Current Base: [4]
68      TOLAYER3: packet being lost
69
70  EVENT time: 53.370399,  type: 2, fromlayer3  entity: 0
71  A | received ACK: [4]
72  A | New base: [5]
73
74  EVENT time: 57.572548,  type: 2, fromlayer3  entity: 1
75  B | received out of order packet: [6]
76  B | send ACK: [4]
77
78  EVENT time: 64.252945,  type: 2, fromlayer3  entity: 0
79  A | ACK is out of date: [4]
80
81  EVENT time: 72.051430,  type: 1, fromlayer5  entity: 0
82  A | send packet: [8]
83  A | Current Base: [5]
84
85  EVENT time: 75.334435,  type: 2, fromlayer3  entity: 1
86  B | received out of order packet: [8]
87  B | send ACK: [4]
88
89  EVENT time: 77.739700,  type: 2, fromlayer3  entity: 0
90  A | ACK is out of date: [4]
91
92  EVENT time: 78.293961,  type: 0, timerinterrupt  entity: 0
93  Time interrupt: base [5], nextseqnum [9]
94  A | send packet: [5]
95      TOLAYER3: packet being corrupted
96  A | send packet: [6]
97  A | send packet: [7]
98      TOLAYER3: packet being lost
99  A | send packet: [8]
100
101  EVENT time: 78.951645,  type: 1, fromlayer5  entity: 0
102  A | send packet: [9]
103  A | Current Base: [5]
104
105  EVENT time: 80.931091,  type: 1, fromlayer5  entity: 0
106  A | send packet: [10]
107  A | Current Base: [5]
108      TOLAYER3: packet being lost
109
```

```
110 EVENT time: 85.308083, type: 2, fromlayer3 entity: 1
111 B | received corrupt packet: [5]
112     TOLAYER3: packet being corrupted
113 B | send ACK: [4]
114
115 EVENT time: 87.071701, type: 2, fromlayer3 entity: 0
116 A | received corrupt ACK: [4]
117
118 EVENT time: 89.789345, type: 1, fromlayer5 entity: 0
119 A | send packet: [11]
120 A | Current Base: [5]
121
122 EVENT time: 92.615036, type: 2, fromlayer3 entity: 1
123 B | received out of order packet: [6]
124 B | send ACK: [4]
125
126 EVENT time: 94.842262, type: 2, fromlayer3 entity: 0
127 A | ACK is out of date: [4]
128
129 EVENT time: 99.468742, type: 0, timerinterrupt entity: 0
130 Time interrupt: base [5], nextseqnum [12]
131 A | send packet: [5]
132 A | send packet: [6]
133 A | send packet: [7]
134 A | send packet: [8]
135 A | send packet: [9]
136 A | send packet: [10]
137 A | send packet: [11]
138
139 EVENT time: 101.557755, type: 2, fromlayer3 entity: 1
140 B | received out of order packet: [8]
141     TOLAYER3: packet being lost
142 B | send ACK: [4]
143
144 EVENT time: 103.008095, type: 1, fromlayer5 entity: 0
145 A | send packet: [12]
146 A | Current Base: [5]
147
148 EVENT time: 105.746201, type: 1, fromlayer5 entity: 0
149 A | window is full. Buffered [13]
150
151 EVENT time: 106.396919, type: 1, fromlayer5 entity: 0
152 A | window is full. Buffered [14]
153
154 EVENT time: 109.731354, type: 2, fromlayer3 entity: 1
155 B | received out of order packet: [9]
156 B | send ACK: [4]
157
158 EVENT time: 113.906517, type: 2, fromlayer3 entity: 0
```

```
159 A | ACK is out of date: [4]
160
161 EVENT time: 115.966682, type: 2, fromlayer3 entity: 1
162 B | received out of order packet: [11]
163 B | send ACK: [4]
164
165 EVENT time: 118.709290, type: 0, timerinterrupt entity: 0
166 Time interrupt: base [5], nextseqnum [13]
167 A | send packet: [5]
168 A | send packet: [6]
169 A | send packet: [7]
170 A | send packet: [8]
171 TOLAYER3: packet being corrupted
172 A | send packet: [9]
173 A | send packet: [10]
174 A | send packet: [11]
175 A | send packet: [12]
176
177 EVENT time: 120.000832, type: 2, fromlayer3 entity: 1
178 B | received in order packet: [5]
179 B | send ACK: [5]
180
181 EVENT time: 121.943054, type: 2, fromlayer3 entity: 1
182 B | received in order packet: [6]
183 B | send ACK: [6]
184
185 EVENT time: 122.972054, type: 1, fromlayer5 entity: 0
186 A | window is full. Buffered [15]
187
188 EVENT time: 123.842583, type: 2, fromlayer3 entity: 0
189 A | ACK is out of date: [4]
190
191 EVENT time: 128.350082, type: 2, fromlayer3 entity: 1
192 B | received in order packet: [7]
193 B | send ACK: [7]
194
195 EVENT time: 130.366135, type: 2, fromlayer3 entity: 0
196 A | received ACK: [5]
197 A | New base: [6]
198
199 EVENT time: 132.262604, type: 2, fromlayer3 entity: 1
200 B | received in order packet: [8]
201 B | send ACK: [8]
202
203 EVENT time: 136.632126, type: 2, fromlayer3 entity: 1
204 B | received in order packet: [9]
205 B | send ACK: [9]
206
207 EVENT time: 137.809479, type: 1, fromlayer5 entity: 0
```

```
208 A | window is full. Buffered [16]
209
210 EVENT time: 139.841980, type: 2, fromlayer3 entity: 0
211 A | received ACK: [6]
212 A | New base: [7]
213
214 EVENT time: 139.896317, type: 1, fromlayer5 entity: 0
215 A | window is full. Buffered [17]
216
217 EVENT time: 145.878143, type: 2, fromlayer3 entity: 0
218 A | received ACK: [7]
219 A | New base: [8]
220
221 EVENT time: 145.966904, type: 2, fromlayer3 entity: 1
222 B | received in order packet: [10]
223         TOLAYER3: packet being lost
224 B | send ACK: [10]
225
226 EVENT time: 149.180206, type: 2, fromlayer3 entity: 1
227 B | received in order packet: [11]
228 B | send ACK: [11]
229
230 EVENT time: 152.139786, type: 2, fromlayer3 entity: 0
231 A | received ACK: [8]
232 A | New base: [9]
233
234 EVENT time: 153.466965, type: 1, fromlayer5 entity: 0
235 A | window is full. Buffered [18]
236
237 EVENT time: 156.402069, type: 2, fromlayer3 entity: 1
238 B | received in order packet: [12]
239 B | send ACK: [12]
240
241 EVENT time: 158.172012, type: 2, fromlayer3 entity: 1
242 B | received out of order packet: [5]
243 B | send ACK: [12]
244
245 EVENT time: 161.366058, type: 2, fromlayer3 entity: 0
246 A | received ACK: [9]
247 A | New base: [10]
248
249 EVENT time: 161.433640, type: 2, fromlayer3 entity: 1
250 B | received out of order packet: [6]
251 B | send ACK: [12]
252
253 EVENT time: 164.517426, type: 1, fromlayer5 entity: 0
254 A | window is full. Buffered [19]
255
256 EVENT time: 169.088348, type: 2, fromlayer3 entity: 1
```

```
257 B | received out of order packet: [7]
258 B | send ACK: [12]
259
260 EVENT time: 170.515030, type: 2, fromlayer3 entity: 0
261 A | received ACK: [11]
262 A | New base: [12]
263
264 EVENT time: 175.502701, type: 2, fromlayer3 entity: 1
265 B | received corrupt packet: [8]
266 B | send ACK: [12]
267
268 EVENT time: 175.756836, type: 2, fromlayer3 entity: 0
269 A | received ACK: [12]
270 A | New base: [13]
271
272 EVENT time: 178.286987, type: 2, fromlayer3 entity: 0
273 A | ACK is out of date: [12]
274
275 EVENT time: 180.363464, type: 1, fromlayer5 entity: 0
276 A | send packet: [20]
277 A | Current Base: [13]
278
279 EVENT time: 184.997391, type: 2, fromlayer3 entity: 1
280 B | received out of order packet: [9]
281 B | send ACK: [12]
282
283 EVENT time: 185.589355, type: 2, fromlayer3 entity: 0
284 A | ACK is out of date: [12]
285
286 EVENT time: 186.222488, type: 2, fromlayer3 entity: 1
287 B | received out of order packet: [10]
288         TOLAYER3: packet being lost
289 B | send ACK: [12]
290
291 EVENT time: 187.351517, type: 2, fromlayer3 entity: 1
292 B | received out of order packet: [11]
293 B | send ACK: [12]
294
295 EVENT time: 188.064240, type: 2, fromlayer3 entity: 0
296 A | ACK is out of date: [12]
297
298 EVENT time: 189.570938, type: 2, fromlayer3 entity: 0
299 A | ACK is out of date: [12]
300
301 EVENT time: 193.482483, type: 2, fromlayer3 entity: 1
302 B | received out of order packet: [12]
303 B | send ACK: [12]
304
305 EVENT time: 197.188309, type: 2, fromlayer3 entity: 1
```

```
306 B | received out of order packet: [20]
307 B | send ACK: [12]
308
309 EVENT time: 197.415497, type: 2, fromlayer3 entity: 0
310 A | ACK is out of date: [12]
311
312 EVENT time: 205.620193, type: 2, fromlayer3 entity: 0
313 A | ACK is out of date: [12]
314
315 EVENT time: 215.352722, type: 2, fromlayer3 entity: 0
316 A | ACK is out of date: [12]
317
318 EVENT time: 219.635651, type: 0, timerinterrupt entity: 0
319 Time interrupt: base [13], nextseqnum [21]
320 A | send packet: [13]
321 A | send packet: [14]
322 A | send packet: [15]
323 A | send packet: [16]
324 A | send packet: [17]
325 A | send packet: [18]
326 A | send packet: [19]
327 A | send packet: [20]
328
329 EVENT time: 222.459183, type: 2, fromlayer3 entity: 0
330 A | ACK is out of date: [12]
331
332 EVENT time: 229.472198, type: 2, fromlayer3 entity: 1
333 B | received in order packet: [13]
334 B | send ACK: [13]
335
336 EVENT time: 233.389084, type: 2, fromlayer3 entity: 0
337 A | received ACK: [13]
338 A | New base: [14]
339
340 EVENT time: 235.067505, type: 2, fromlayer3 entity: 1
341 B | received in order packet: [14]
342 B | send ACK: [14]
343
344 EVENT time: 239.929993, type: 2, fromlayer3 entity: 1
345 B | received in order packet: [15]
346 B | send ACK: [15]
347
348 EVENT time: 244.473999, type: 2, fromlayer3 entity: 0
349 A | received ACK: [14]
350 A | New base: [15]
351
352 EVENT time: 246.001297, type: 2, fromlayer3 entity: 1
353 B | received in order packet: [16]
354 B | send ACK: [16]
```



```
355
356 EVENT time: 247.060333, type: 2, fromlayer3 entity: 0
357 A | received ACK: [15]
358 A | New base: [16]
359
360 EVENT time: 254.289307, type: 2, fromlayer3 entity: 0
361 A | received ACK: [16]
362 A | New base: [17]
363
364 EVENT time: 254.894257, type: 2, fromlayer3 entity: 1
365 B | received in order packet: [17]
366 B | send ACK: [17]
367
368 EVENT time: 258.970337, type: 2, fromlayer3 entity: 1
369 B | received in order packet: [18]
370 B | send ACK: [18]
371
372 EVENT time: 261.243530, type: 2, fromlayer3 entity: 0
373 A | received ACK: [17]
374 A | New base: [18]
375
376 EVENT time: 264.457733, type: 2, fromlayer3 entity: 0
377 A | received ACK: [18]
378 A | New base: [19]
379
380 EVENT time: 265.813202, type: 2, fromlayer3 entity: 1
381 B | received in order packet: [19]
382 TOLAYER3: packet being lost
383 B | send ACK: [19]
384
385 EVENT time: 269.982971, type: 2, fromlayer3 entity: 1
386 B | received in order packet: [20]
387 TOLAYER3: packet being corrupted
388 B | send ACK: [20]
389
390 EVENT time: 274.826782, type: 2, fromlayer3 entity: 0
391 A | received corrupt ACK: [20]
392
393 EVENT time: 310.811249, type: 0, timerinterrupt entity: 0
394 Time interrupt: base [19], nextseqnum [21]
395 A | send packet: [19]
396 A | send packet: [20]
397
398 EVENT time: 320.604248, type: 2, fromlayer3 entity: 1
399 B | received out of order packet: [19]
400 B | send ACK: [20]
401
402 EVENT time: 327.095001, type: 2, fromlayer3 entity: 1
403 B | received out of order packet: [20]
```

```

404          TOLAYER3: packet being lost
405 B | send ACK: [20]
406
407 EVENT time: 328.683777, type: 2, fromlayer3 entity: 0
408 A | received ACK: [20]
409 A | New base: [21]
410 A | Empty buffer
411   Simulator terminated at time 328.683777
412   after sending 20 msgs from layer5
413 Next Seq num: [21], txLast: [21]
414 Total number of sent packets: 97

```

(b) 50 0.3 0.3 10 2

## Loss

當 A 送出第一個 packet 後發生 packet lost (Line9-13) ，此時 B 的 Expected Seqnum = 1 ，將等到成功收到 A 的 seqnum = 1 的資料後才會傳送 acknum = 1 的 packet 讓 A 更新 base 。

在 Line15-74 ，A 不斷收到從 Layer5 的資訊並傳送到 B ，不過因為尚未收到 Expected seqnum = 1 ，而持續傳送 acknum = 0 給 A 。直到 A 的 timer 到達後，啟動 GBN 機制重新傳送 seqnum = 1 - 6 的所有資料 (Line 76-86) 。

## Corrupt

啟動 GBN 機制重新傳送的 seqnum = 1 的 packet 發生 corrupt (Line78-79) ，因此 B 收到 corrupt 後的 packet (Line88 - 91) 即便 seqnum = Expected seqnum ，也會重新傳送 acknum = lastacknum 回去給 A 。

無法在 Timeout 時間內得到從 B 回傳的 acknum = 1 ，將使得 A 不斷啟動 GBN 機制，直到 Packet seqnum = 1 能在沒有 loss, corrupt 的情況下傳到 B (Line 179) 且 B 的 acknum = 1 的 packet 能沒有 loss 且 corrupt 的情況下回送到 A (Line226 收到 seqnum = 1 、Line252 傳送 no loss, no corrupt acknum=1) ，才會更新 base 到 1 的狀態 (Line264-266) 。

```

1  ----- Stop and wait Network Simulator Version 1.1 -----
2
3  the number of messages to simulate: 50
4  packet loss probability: 0.300000
5  packet corruption probability: 0.300000
6  average time between messages from sender's layer5: 10.000000
7  TRACE: 2
8
9  EVENT time: 6.965711, type: 1, fromlayer5 entity: 0
10 A | send packet: [1]
11 A | Current Base: [1]
12          TOLAYER3: packet being lost
13 A | Empty buffer, restart timer
14
15 EVENT time: 19.661861, type: 1, fromlayer5 entity: 0
16 A | send packet: [2]
17 A | Current Base: [1]

```

```
18
19  EVENT time: 25.912575,  type: 2, fromlayer3  entity: 1
20  B | received out of order packet: [2]
21      TOLAYER3: packet being lost
22  B | send ACK: [0]
23
24  EVENT time: 29.459408,  type: 1, fromlayer5  entity: 0
25  A | send packet: [3]
26  A | Current Base: [1]
27
28  EVENT time: 36.965710,  type: 0, timerinterrupt  entity: 0
29  Time interrupt: base [1], nextseqnum [4]
30  A | send packet: [1]
31      TOLAYER3: packet being lost
32  A | send packet: [2]
33  A | send packet: [3]
34
35  EVENT time: 38.439957,  type: 1, fromlayer5  entity: 0
36  A | send packet: [4]
37  A | Current Base: [1]
38
39  EVENT time: 38.783726,  type: 1, fromlayer5  entity: 0
40  A | send packet: [5]
41  A | Current Base: [1]
42      TOLAYER3: packet being lost
43
44  EVENT time: 38.987537,  type: 2, fromlayer3  entity: 1
45  B | received out of order packet: [3]
46  B | send ACK: [0]
47
48  EVENT time: 46.504753,  type: 2, fromlayer3  entity: 0
49  A | ACK is out of date: [0]
50
51  EVENT time: 47.289467,  type: 2, fromlayer3  entity: 1
52  B | received out of order packet: [2]
53  B | send ACK: [0]
54
55  EVENT time: 54.164230,  type: 2, fromlayer3  entity: 0
56  A | ACK is out of date: [0]
57
58  EVENT time: 57.077896,  type: 2, fromlayer3  entity: 1
59  B | received out of order packet: [3]
60      TOLAYER3: packet being lost
61  B | send ACK: [0]
62
63  EVENT time: 58.173267,  type: 1, fromlayer5  entity: 0
64  A | send packet: [6]
65  A | Current Base: [1]
66
```

```
67  EVENT time: 64.031258,  type: 2, fromlayer3  entity: 1
68  B | received out of order packet: [4]
69      TOLAYER3: packet being lost
70  B | send ACK: [0]
71
72  EVENT time: 66.852463,  type: 2, fromlayer3  entity: 1
73  B | received out of order packet: [6]
74  B | send ACK: [0]
75
76  EVENT time: 66.965714,  type: 0, timerinterrupt  entity: 0
77  Time interrupt: base [1], nextseqnum [7]
78  A | send packet: [1]
79      TOLAYER3: packet being corrupted
80  A | send packet: [2]
81      TOLAYER3: packet being corrupted
82  A | send packet: [3]
83  A | send packet: [4]
84  A | send packet: [5]
85      TOLAYER3: packet being lost
86  A | send packet: [6]
87
88  EVENT time: 73.307373,  type: 2, fromlayer3  entity: 1
89  B | received corrupt packet: [1]
90      TOLAYER3: packet being lost
91  B | send ACK: [0]
92
93  EVENT time: 73.532860,  type: 2, fromlayer3  entity: 0
94  A | ACK is out of date: [0]
95
96  EVENT time: 75.712639,  type: 2, fromlayer3  entity: 1
97  B | received corrupt packet: [999999]
98  B | send ACK: [0]
99
100  EVENT time: 76.511520,  type: 1, fromlayer5  entity: 0
101  A | send packet: [7]
102  A | Current Base: [1]
103      TOLAYER3: packet being lost
104
105  EVENT time: 77.072357,  type: 2, fromlayer3  entity: 1
106  B | received out of order packet: [3]
107      TOLAYER3: packet being lost
108  B | send ACK: [0]
109
110  EVENT time: 83.886238,  type: 2, fromlayer3  entity: 0
111  A | ACK is out of date: [0]
112
113  EVENT time: 84.379311,  type: 2, fromlayer3  entity: 1
114  B | received out of order packet: [4]
115      TOLAYER3: packet being lost
```

```
116 B | send ACK: [0]
117
118 EVENT time: 85.369774, type: 1, fromlayer5 entity: 0
119 A | send packet: [8]
120 A | Current Base: [1]
121
122 EVENT time: 85.712318, type: 1, fromlayer5 entity: 0
123 A | window is full. Buffered [9]
124
125 EVENT time: 93.322029, type: 2, fromlayer3 entity: 1
126 B | received out of order packet: [6]
127         TOLAYER3: packet being corrupted
128 B | send ACK: [0]
129
130 EVENT time: 93.948608, type: 0, timerinterrupt entity: 0
131 Time interrupt: base [1], nextseqnum [9]
132 A | send packet: [1]
133         TOLAYER3: packet being corrupted
134 A | send packet: [2]
135         TOLAYER3: packet being lost
136 A | send packet: [3]
137 A | send packet: [4]
138 A | send packet: [5]
139 A | send packet: [6]
140 A | send packet: [7]
141         TOLAYER3: packet being corrupted
142 A | send packet: [8]
143         TOLAYER3: packet being lost
144
145 EVENT time: 97.346382, type: 1, fromlayer5 entity: 0
146 A | window is full. Buffered [10]
147
148 EVENT time: 99.212746, type: 2, fromlayer3 entity: 0
149 A | received corrupt ACK: [0]
150
151 EVENT time: 100.084488, type: 1, fromlayer5 entity: 0
152 A | window is full. Buffered [11]
153
154 EVENT time: 100.270470, type: 2, fromlayer3 entity: 1
155 B | received out of order packet: [8]
156         TOLAYER3: packet being corrupted
157 B | send ACK: [0]
158
159 EVENT time: 104.304619, type: 2, fromlayer3 entity: 1
160 B | received corrupt packet: [1]
161 B | send ACK: [0]
162
163 EVENT time: 109.974426, type: 2, fromlayer3 entity: 1
164 B | received out of order packet: [3]
```

```
165 B | send ACK: [0]
166
167 EVENT time: 110.219078, type: 2, fromlayer3 entity: 0
168 A | received corrupt ACK: [0]
169
170 EVENT time: 114.394241, type: 2, fromlayer3 entity: 0
171 A | ACK is out of date: [0]
172
173 EVENT time: 118.216049, type: 2, fromlayer3 entity: 1
174 B | received out of order packet: [4]
175 B | send ACK: [0]
176
177 EVENT time: 118.402412, type: 0, timerinterrupt entity: 0
178 Time interrupt: base [1], nextseqnum [9]
179 A | send packet: [1]
180 A | send packet: [2]
181 TOLAYER3: packet being corrupted
182 A | send packet: [3]
183 TOLAYER3: packet being corrupted
184 A | send packet: [4]
185 A | send packet: [5]
186 TOLAYER3: packet being lost
187 A | send packet: [6]
188 TOLAYER3: packet being corrupted
189 A | send packet: [7]
190 A | send packet: [8]
191
192 EVENT time: 119.422493, type: 1, fromlayer5 entity: 0
193 A | window is full. Buffered [12]
194
195 EVENT time: 120.225113, type: 2, fromlayer3 entity: 1
196 B | received out of order packet: [5]
197 B | send ACK: [0]
198
199 EVENT time: 122.270142, type: 2, fromlayer3 entity: 0
200 A | ACK is out of date: [0]
201
202 EVENT time: 124.040085, type: 2, fromlayer3 entity: 0
203 A | ACK is out of date: [0]
204
205 EVENT time: 126.651772, type: 2, fromlayer3 entity: 0
206 A | ACK is out of date: [0]
207
208 EVENT time: 126.763123, type: 2, fromlayer3 entity: 1
209 B | received out of order packet: [6]
210 B | send ACK: [0]
211
212 EVENT time: 129.298065, type: 1, fromlayer5 entity: 0
213 A | window is full. Buffered [13]
```

```
214
215 EVENT time: 132.799286, type: 2, fromlayer3 entity: 0
216 A | ACK is out of date: [0]
217
218 EVENT time: 134.829788, type: 1, fromlayer5 entity: 0
219 A | Window is full. Buffered [14]
220
221 EVENT time: 135.356522, type: 2, fromlayer3 entity: 1
222 B | received corrupt packet: [7]
223 B | send ACK: [0]
224
225 EVENT time: 138.618149, type: 2, fromlayer3 entity: 1
226 B | received in order packet: [1]
227     TOLAYER3: packet being lost
228 B | send ACK: [1]
229
230 EVENT time: 143.144287, type: 0, timerinterrupt entity: 0
231 Time interrupt: base [1], nextseqnum [9]
232 A | send packet: [1]
233     TOLAYER3: packet being lost
234 A | send packet: [2]
235 A | send packet: [3]
236 A | send packet: [4]
237     TOLAYER3: packet being lost
238 A | send packet: [5]
239     TOLAYER3: packet being corrupted
240 A | send packet: [6]
241 A | send packet: [7]
242     TOLAYER3: packet being corrupted
243 A | send packet: [8]
244     TOLAYER3: packet being lost
245
246 EVENT time: 143.260559, type: 2, fromlayer3 entity: 0
247 A | ACK is out of date: [0]
248
249 EVENT time: 146.272858, type: 2, fromlayer3 entity: 1
250 B | received corrupt packet: [2]
251     TOLAYER3: packet being corrupted
252 B | send ACK: [1]
253
254 EVENT time: 146.522339, type: 1, fromlayer5 entity: 0
255 A | Window is full. Buffered [15]
256
257 EVENT time: 147.318909, type: 2, fromlayer3 entity: 1
258 B | received corrupt packet: [3]
259 B | send ACK: [1]
260
261 EVENT time: 147.779556, type: 2, fromlayer3 entity: 0
262 A | received corrupt ACK: [1]
```

263

264 EVENT time: 150.368759, type: 2, fromlayer3 entity: 0

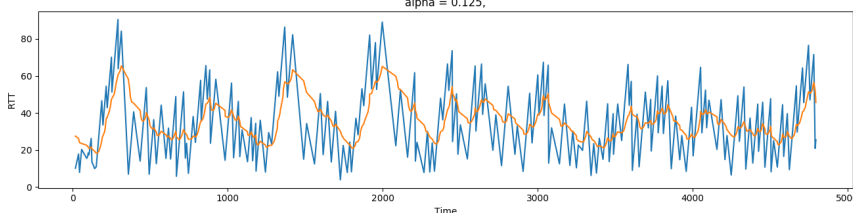
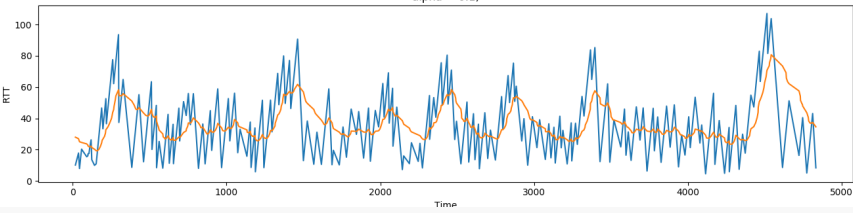
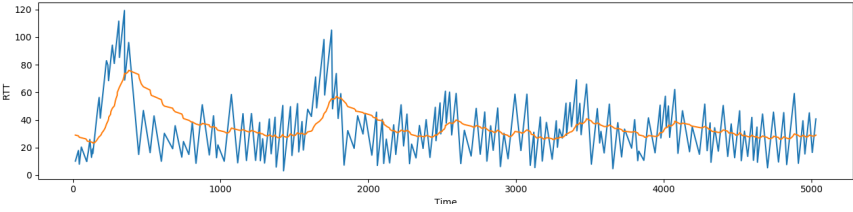
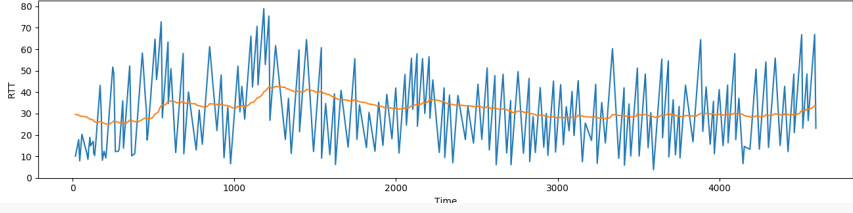
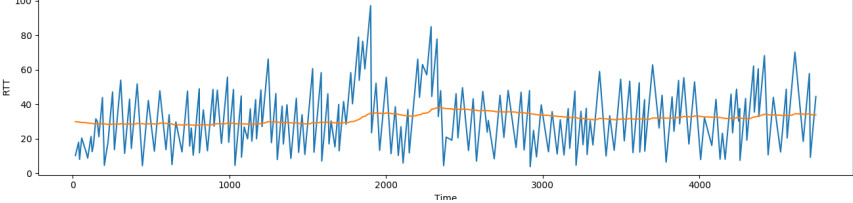
265 A | received ACK: [1]

266 A | New base: [2]

## Exponential Weighted Moving Average

由 Estimated RTT 的公式可以推測當  $\alpha$  越大時，分配在 Sample RTT 的權重越大，分配在 Estimated RTT 的權重越小，Estimated RTT 的曲線分佈變化大。當逐步將  $\alpha$  下調至 0.01 後則趨近近乎於平坦狀態。

$$\text{Estimated RTT}_i = (1 - \alpha)\text{Estimated RTT}_{i-1} + \alpha\text{Sample RTT}_i$$

RTT-Time	# packet
	8328
	8907
	8121
	8394
	8995



之所以採用 Exponential Weighted Moving Average 的原因在於：動態調整 Timer 的 Retransmission Timeout 值，在等待 receiver ACK 和 Packet Loss 兩者之間取得平衡，在給定相同的資料傳輸量下，最小化傳送封包的數目。

以下實驗為給定傳送 Total messages = 1000 的情況下，使用不同  $\alpha$  值對應的所需的 Total number of packets 數量。10000 為人為設定值，為封包傳送上限。因為在特定情況下會因為 Loss, corrupt rate 和 alpha 達到某種平衡，而使得封包不斷的傳送失敗。

忽略到 10000 的數值，可以發現封包平均而言在  $\alpha < 0.25$  傳送數量較少。雖然網路連線的狀態 (i.e., packet loss, corrupt rate) 可能會與  $\alpha$  達成某種平衡，但以機率觀點視之，選擇  $\alpha$  較小的數值能得到較低的封包傳送數期望值。

