



**Department of Electronic and Telecommunication Engineering**  
**University of Moratuwa**

**Practical Session 1**

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This report is submitted as a partial fulfillment of the module

**EN2150 – Communication Network Engineering**

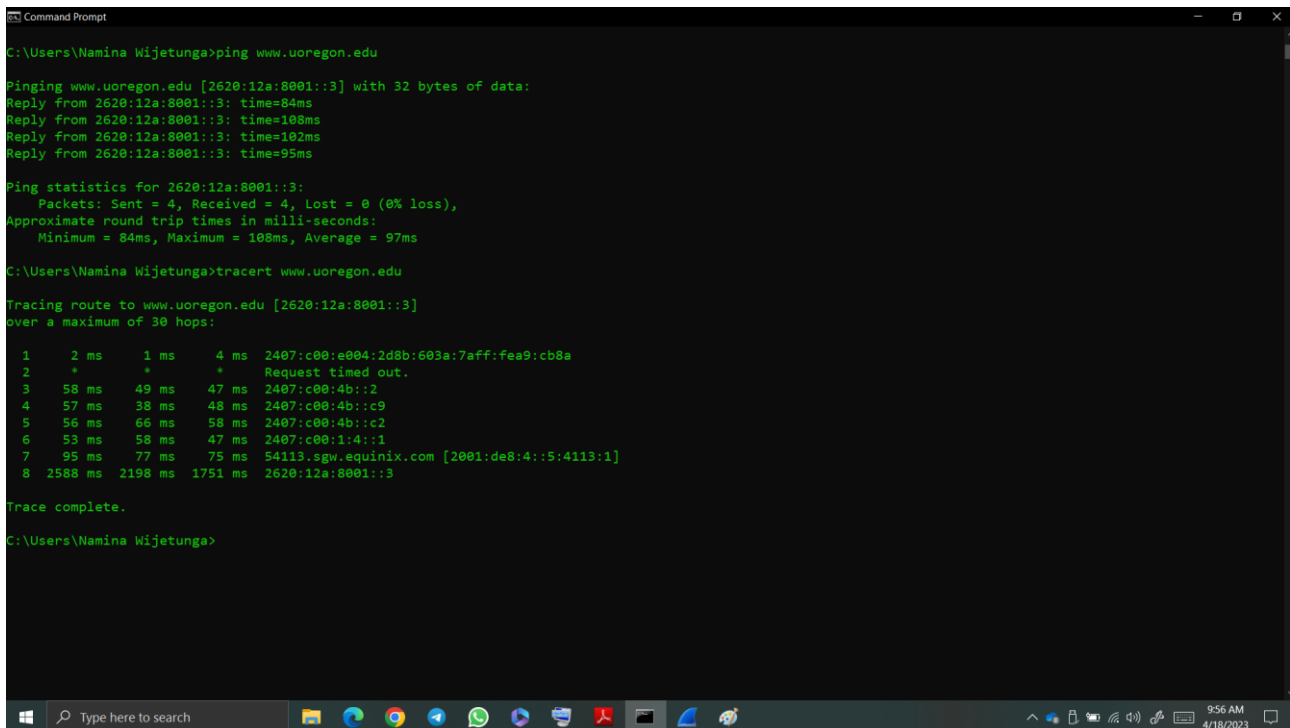
24<sup>nd</sup> of March 2023

## Question (1) - What is a hierarchical network? Networks aggregating at different levels

b) Activate Wireshark packet capture and perform the following:

- I. Access each of the following web pages and then Ping and Traceroute to the same web pages. Copy the results to a file for later analysis.

- **www.uoregon.edu**



```
C:\Users\Namina Wijetunga>ping www.uoregon.edu

Pinging www.uoregon.edu [2620:12a:8001::3] with 32 bytes of data:
Reply from 2620:12a:8001::3: time=84ms
Reply from 2620:12a:8001::3: time=108ms
Reply from 2620:12a:8001::3: time=102ms
Reply from 2620:12a:8001::3: time=95ms

Ping statistics for 2620:12a:8001::3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 84ms, Maximum = 108ms, Average = 97ms

C:\Users\Namina Wijetunga>tracert www.uoregon.edu

Tracing route to www.uoregon.edu [2620:12a:8001::3]
over a maximum of 30 hops:
  0  2 ms   1 ms   4 ms  2407:c00:e004:2d8b:603a:7aff:fea9:cb8a
  1  *      *      *      Request timed out.
  2  58 ms  49 ms  47 ms  2407:c00:4b::2
  3  57 ms  38 ms  48 ms  2407:c00:4b::c9
  4  56 ms  66 ms  58 ms  2407:c00:4b::c2
  5  53 ms  58 ms  47 ms  2407:c00:1:4::1
  6  95 ms  77 ms  75 ms  54113.sgw.equinix.com [2001:de8:4::5:4113:1]
  7  2588 ms 2198 ms 1751 ms 2620:12a:8001::3

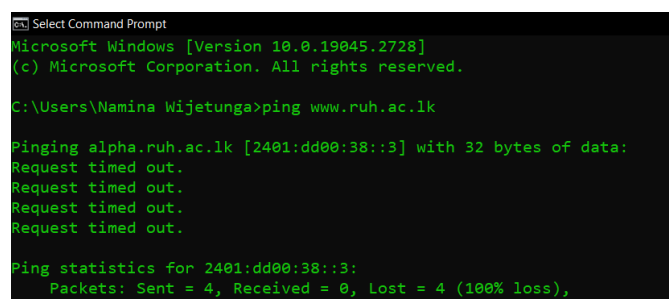
Trace complete.

C:\Users\Namina Wijetunga>
```

Using the IP address geolocator,

1. 2407:c00:e004:2d8b:603a:7aff:fea9:cb8a - Jaffna, Sri Lanka - Mobitel Pvt Ltd
2. 2407:c00:4b::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
3. 2407:c00:4b::c9 - Colombo, Sri Lanka - Mobitel Pvt Ltd
4. 2407:c00:4b::c2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
5. 2407:c00:1:4::1 - Colombo, Sri Lanka - Mobitel Pvt Ltd
6. 2001:de8:4::5:4113:1 - Tokyo, Japan - Equinix Asia Pacific Pte Ltd
7. 2620:12a:8001::3 - San Francisco, USA - Pantheon

- **www.ruh.ac.lk**



```
Select Command Prompt
Microsoft Windows [Version 10.0.19045.2728]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Namina Wijetunga>ping www.ruh.ac.lk

Pinging alpha.ruh.ac.lk [2401:dd00:38::3] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 2401:dd00:38::3:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

```
Command Prompt
C:\Users\Namina Wijetunga>tracert www.ruh.ac.lk

Tracing route to alpha.ruh.ac.lk [2401:dd00:38::3]
over a maximum of 30 hops:

  0  2 ms   1 ms   1 ms  2407:c00:e004:2d8b:603a:7aff:fea9:cb8a
  1  *      *      *      Request timed out.
  2  36 ms  40 ms  33 ms 2407:c00:4b::2
  3  227 ms 256 ms 127 ms 2407:c00:4b::c9
  4  236 ms 151 ms 85 ms 2407:c00:4b::c2
  5  576 ms 491 ms 255 ms 2407:c00:1:4::1
  6  607 ms 332 ms 296 ms 2001:de9:0:8::1
  7  258 ms 360 ms 269 ms 2401:dd00:38::3
  8  *      *      *      Request timed out.
  9  *      *      *      Request timed out.
 10  *      *      *      Request timed out.
 11  *      *      *      Request timed out.
 12  *      *      *      Request timed out.
 13  *      *      *      Request timed out.
 14  *      *      *      Request timed out.
 15  *      *      *      Request timed out.
 16  *      *      *      Request timed out.
 17  *      *      *      Request timed out.
 18  *      *      *      Request timed out.
 19  *      *      *      Request timed out.
 20  *      *      *      Request timed out.
 21  *      *      *      Request timed out.
 22  *      *      *      Request timed out.
 23  *      *      *      Request timed out.
 24  *      *      *      Request timed out.
 25  *      *      *      Request timed out.
 26  *      *      *      Request timed out.
 27  *      *      *      Request timed out.
 28  *      *      *      Request timed out.
 29  *      *      *      Request timed out.
 30  *      *      *      Request timed out.

Trace complete.

C:\Users\Namina Wijetunga>ping www.ruh.ac.lk
```

Using the IP address geolocator,

1. 2407:c00:e004:2d8b:603a:7aff:fea9:cb8a - Jaffna, Sri Lanka - Mobitel Pvt Ltd
2. 2407:c00:4b::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
3. 2407:c00:4b::c9 - Colombo, Sri Lanka - Mobitel Pvt Ltd
4. 2407:c00:4b::c2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
5. 2407:c00:1:4::1 - Colombo, Sri Lanka - Mobitel Pvt Ltd
6. 2001:de9:0:8::1 - Colombo, Sri Lanka - Sri Lanka Telecom PLC
7. 2401:dd00:38 - Colombo, Sri Lanka - Lanka Education and Research Network

• **www.keio.ac.jp**

```
Command Prompt
C:\Users\Namina Wijetunga>ping www.keio.ac.jp

Pinging e100342.dscb.akamaiedge.net [2600:1417:75::17d4:fd58] with 32 bytes of data:
Reply from 2600:1417:75::17d4:fd58: time=234ms
Reply from 2600:1417:75::17d4:fd58: time=205ms
Reply from 2600:1417:75::17d4:fd58: time=79ms
Reply from 2600:1417:75::17d4:fd58: time=49ms

Ping statistics for 2600:1417:75::17d4:fd58:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 49ms, Maximum = 234ms, Average = 141ms

C:\Users\Namina Wijetunga>tracert www.keio.ac.jp

Tracing route to e100342.dscb.akamaiedge.net [2600:1417:75::17d4:fd59]
over a maximum of 30 hops:

  0  1 ms   1 ms   1 ms  2407:c00:e004:2d8b:603a:7aff:fea9:cb8a
  1  *      *      *      Request timed out.
  2  60 ms  49 ms  48 ms 2407:c00:4b::2
  3  584 ms 589 ms 460 ms 2407:c00:4b::c9
  4  88 ms  48 ms  86 ms 2407:c00:4b::c2
  5  420 ms 524 ms 190 ms 2407:c00:1:4::1
  6  57 ms  59 ms  49 ms 2001:df4:1b00:a002::
  7  *      *      *      Request timed out.
  8  438 ms 478 ms 456 ms 2001:df4:1b00:2000::d
  9  78 ms  141 ms 289 ms 2401:7500:fff6::100
 10  160 ms 67 ms  77 ms g2600-1417-0075-0000-0000-0000-17d4-fd59.deploy.static.akamaitechnologies.com [2600:1417:75::17d4:fd59]

Trace complete.

C:\Users\Namina Wijetunga>
```

Using the IP address geolocator,

1. 2407:c00:e004:2d8b:603a:7aff:fea9:cb8a - Jaffna, Sri Lanka - Mobitel Pvt Ltd
2. 2407:c00:4b::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
3. 2407:c00:4b::c9 - Colombo, Sri Lanka - Mobitel Pvt Ltd
4. 2407:c00:4b::c2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
5. 2407:c00:1:4::1 - Colombo, Sri Lanka - Mobitel Pvt Ltd
6. 2001:df4:1b00:a002:: - Colombo, Sri Lanka - Sri Lanka Telecom PLC
7. 2001:df4:1b00:2000::d - Colombo, Sri Lanka - Sri Lanka Telecom PLC
8. 2401:7500:fff6::100 - Mumbai, India - Web Werks India Pvt. Ltd.
9. 2600:1417:75::17d4:fd59 - Mumbai, India - Akamai Technologies Inc.

### • Japan.go.jp

```
Trace complete.

C:\Users\Namina Wijetunga>ping Japan.go.jp

Pinging japan.go.jp [2600:9000:204c:7800:16:ce0d:a300:93a1] with 32 bytes of data:
Reply from 2600:9000:204c:7800:16:ce0d:a300:93a1: time=91ms
Reply from 2600:9000:204c:7800:16:ce0d:a300:93a1: time=116ms
Reply from 2600:9000:204c:7800:16:ce0d:a300:93a1: time=113ms
Reply from 2600:9000:204c:7800:16:ce0d:a300:93a1: time=209ms

Ping statistics for 2600:9000:204c:7800:16:ce0d:a300:93a1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 91ms, Maximum = 209ms, Average = 132ms

C:\Users\Namina Wijetunga>tracert Japan.go.jp

Tracing route to japan.go.jp [2600:9000:204c:7800:16:ce0d:a300:93a1]
over a maximum of 30 hops:

  0  2 ms   1 ms   5 ms  2407:c00:e004:2d8b:603a:7aff:fea9:cb8a
  1  *      *      *      Request timed out.
  2  54 ms  38 ms  47 ms  2407:c00:4b::2
  3  48 ms  47 ms  58 ms  2407:c00:4b::c9
  4  72 ms  48 ms  48 ms  2407:c00:4b::c2
  5  62 ms  37 ms  58 ms  2407:c00:1:4::1
  6  123 ms 87 ms  78 ms  38895.sgw.equinix.com [2001:de8:4::3:8895:1]
  7  101 ms 78 ms 117 ms 2400:6500::24
  8  *      *      *      Request timed out.
  9  122 ms 117 ms 119 ms 2600:9000:fff:ff00::300
 10 102 ms 118 ms 78 ms 2600:9000:fff:ff01:0:50:111:31
 11 115 ms 117 ms 78 ms 2600:9000:fff:ff00::401
 12 *      *      *      Request timed out.
 13 *      *      *      Request timed out.
 14 *      *      *      Request timed out.
 15 90 ms 75 ms 79 ms 2600:9000:204c:7800:16:ce0d:a300:93a1

Trace complete.

C:\Users\Namina Wijetunga>
```

Using the IP address geolocator,

1. 2407:c00:e004:2d8b:603a:7aff:fea9:cb8a - Jaffna, Sri Lanka - Mobitel Pvt Ltd
2. 2407:c00:4b::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
3. 2407:c00:4b::c9 - Colombo, Sri Lanka - Mobitel Pvt Ltd
4. 2407:c00:4b::c2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
5. 2407:c00:1:4::1 - Colombo, Sri Lanka - Mobitel Pvt Ltd
6. 2001:de8:4::3:8895:1 - Singapore - Equinix Japan
7. 2400:6500::24 - Singapore - Amazon Asia-Pacific Resources Private Limited
8. 2600:9000:fff:ff00::300 - Washington, USA - Amazon.com Inc.
9. 2600:9000:fff:ff01:0:50:111:31 - Washington, USA - Amazon.com Inc.
10. 2600:9000:fff:ff00::401 - Washington, USA - Amazon.com Inc.

- 2600:9000:204c:7800:16:ce0d:a300:93a1 - Washington, USA - Amazon.com Inc.

- **nsf.gov**

```
Command Prompt
Trace complete.

C:\Users\Namina Wijetunga>ping nsf.gov

Pinging nsf.gov [2620:10f:6002:221::106] with 32 bytes of data:
Reply from 2620:10f:6002:221::106: time=336ms
Reply from 2620:10f:6002:221::106: time=325ms
Reply from 2620:10f:6002:221::106: time=316ms
Reply from 2620:10f:6002:221::106: time=415ms

Ping statistics for 2620:10f:6002:221::106:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 316ms, Maximum = 415ms, Average = 348ms
```

```
Command Prompt
C:\Users\Namina Wijetunga>tracert nsf.gov

Tracing route to nsf.gov [2620:10f:6002:221::106]
over a maximum of 30 hops:

  0  1 ms   1 ms   1 ms  2407:c00:e004:2d8b:603a:7aff:fea9:cb8a
  1  *      *      *      Request timed out.
  2  63 ms  37 ms  57 ms  2407:c00:4b::2
  3  59 ms  47 ms  37 ms  2407:c00:4b::c9
  4  79 ms  38 ms  47 ms  2407:c00:4b::c2
  5  48 ms  37 ms  32 ms  2407:c00:1:4::1
  6  50 ms  37 ms  36 ms  2407:c00:1:5::2
  7  106 ms 77 ms  77 ms  ae-6.a00.sngpsi03.sg.bb.gin.ntt.net [2001:218:4000:5000::2cd]
  8  *      98 ms  77 ms  ae-13.r23.sngpsi07.sg.bb.gin.ntt.net [2001:218:0:2000::1ad]
  9  138 ms 74 ms  79 ms  ae-1.r01.sngpsi07.sg.bb.gin.ntt.net [2001:218:0:2000::86]
 10 107 ms 77 ms  77 ms  ae-11.edge3.Singapore3.Level3.net [2001:1900:7:3::101]
 11 *      *      *      Request timed out.
 12 324 ms 317 ms 317 ms  Lumen-level3-LosAngeles1.Level3.net [2001:1900:4:3::e2]
 13 335 ms 433 ms 326 ms  2001:428::205:171:203:158
 14 449 ms 306 ms 317 ms  2001:428:9001:101::2
 15 467 ms 317 ms 317 ms  2001:428:2402:1a:0:bd:0:2
 16 422 ms 477 ms 317 ms  2001:428:2402:a:0:68:0:1
 17 *      *      *      Request timed out.
 18 330 ms 312 ms 322 ms  2001:428:2500:1c::2
 19 360 ms 318 ms 327 ms  2620:10f:6011:1::1
 20 427 ms 482 ms 347 ms  2620:10f:6011:2::1
 21 325 ms 442 ms 317 ms  www.nsf.gov [2620:10f:6002:221::106]

Trace complete.

C:\Users\Namina Wijetunga>
```

Using the IP address geolocator,

- 2407:c00:e004:2d8b:603a:7aff:fea9:cb8a - Jaffna, Sri Lanka - Mobitel Pvt Ltd
- 2407:c00:4b::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
- 2407:c00:4b::c9 - Colombo, Sri Lanka - Mobitel Pvt Ltd
- 2407:c00:4b::c2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
- 2407:c00:1:4::1 - Colombo, Sri Lanka - Mobitel Pvt Ltd
- 2407:c00:1:5::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
- 2001:218:4000:5000::2cd - Tokyo, Japan - NTT Ltd Japan Corporation
- 2001:218:0:2000::1ad - Tokyo, Japan - NTT Ltd Japan Corporation
- 2001:218:0:2000::86 - Singapore - NTT Ltd Japan Corporation
- 2001:1900:7:3::101 - California, USA - Level 3 Communications Inc.
- 2001:1900:4:3::e2 - New York, USA - Level 3 Communications Inc

12. 2001:428::205:171:203:158 - California, USA - CenturyLink Communications LLC
13. 2001:428:9001:101::2 - Washington, USA - CenturyLink Communications LLC
14. 2001:428:2402:1a:0:bd:0:2 - Louisiana, USA - CenturyLink Communications LLC
15. 2001:428:2402:a:0:68:0:1 - Louisiana, USA - CenturyLink Communications LLC
16. 2001:428:2500:1c::2 - New York, USA - CenturyLink Communications LLC
17. 2620:10f:6011:1::1 - Virginia, USA - National Science Foundation
18. 2620:10f:6011:2::1 - Virginia, USA - National Science Foundation
19. 2620:10f:6002:221::106 - Virginia, USA - National Science Foundation

- **www.cam.ac.uk**

```

Command Prompt

Trace complete.

C:\Users\Namina Wijetunga>ping www.cam.ac.uk

Pinging www.cam.ac.uk [2a05:b400:5:270::80e8:8408] with 32 bytes of data:
Reply from 2a05:b400:5:270::80e8:8408: time=332ms
Reply from 2a05:b400:5:270::80e8:8408: time=293ms
Reply from 2a05:b400:5:270::80e8:8408: time=277ms
Reply from 2a05:b400:5:270::80e8:8408: time=337ms

Ping statistics for 2a05:b400:5:270::80e8:8408:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 277ms, Maximum = 337ms, Average = 309ms

```

```

Command Prompt

C:\Users\Namina Wijetunga>tracert www.cam.ac.uk

Tracing route to www.cam.ac.uk [2a05:b400:5:270::80e8:8408]
over a maximum of 30 hops:

  0  2 ms   1 ms   1 ms  2407:c00:e004:2d8b:603a:7aff:fea9:cb8a
  1  *      *      *      Request timed out.
  2  *      *      *      Request timed out.
  3  55 ms  37 ms  37 ms  2407:c00:4b::2
  4  71 ms  37 ms  58 ms  2407:c00:4b::c9
  5  57 ms  48 ms  56 ms  2407:c00:4b::c2
  6  139 ms 67 ms  37 ms  2407:c00:1:4::1
  7  54 ms  59 ms  45 ms  2407:c00:1:5::2
  8  112 ms 78 ms  117 ms ae-6.a00.sngpsi03.sg.bb.gin.ntt.net [2001:218:4000:5000::2cd]
  9  *      133 ms 114 ms ae-13.r23.sngpsi07.sg.bb.gin.ntt.net [2001:218:0:2000::1ad]
10  101 ms 78 ms  *      ae-1.r01.sngpsi07.sg.bb.gin.ntt.net [2001:218:0:2000::86]
11  126 ms 87 ms  117 ms ae-11.edge3.Singapore3.Level3.net [2001:1900:7:3::101]
12  369 ms 277 ms 247 ms 2001:1900:2::3:83
13  245 ms 280 ms 314 ms JANET.ear3.London2.Level3.net [2001:1900:5:2:2:0:110:1e2]
14  398 ms 508 ms 509 ms ae24.londtt-sbr1.ja.net [2001:630:0:10::39]
15  300 ms 317 ms 318 ms ae28.londtw-sbr2.ja.net [2001:630:0:10::2e]
16  342 ms 318 ms 317 ms ae31.lowdss-sbr1.ja.net [2001:630:0:10::1e5]
17  427 ms 228 ms 236 ms ae26.lowdss-ban1.ja.net [2001:630:0:10::272]
18  399 ms 317 ms 317 ms 2001:630:0:8014::a
19  273 ms 319 ms 318 ms b-jc.c-hi.net.cam.ac.uk [2001:630:210:321::1]
20  422 ms 318 ms 317 ms c-hi.d-dw.net.cam.ac.uk [2001:630:210:318::2]
21  292 ms 277 ms 267 ms d-dw.s-dw.net.cam.ac.uk [2001:630:210:2000::2]
22  379 ms 307 ms 318 ms 2a05:b400:5:ff01::2
23  257 ms 357 ms 316 ms f-sv-net.f-sv-uis.net.cam.ac.uk [2a05:b400:5:ff11::2]
24  268 ms 330 ms 234 ms tm-128-232-132-8.tm.uis.cam.ac.uk [2a05:b400:5:270::80e8:8408]

Trace complete.

C:\Users\Namina Wijetunga>

```

Using the IP address geolocator,

1. 2407:c00:e004:2d8b:603a:7aff:fea9:cb8a - Jaffna, Sri Lanka - Mobitel Pvt Ltd

2. 2407:c00:4b::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
3. 2407:c00:4b::c9 - Colombo, Sri Lanka - Mobitel Pvt Ltd
4. 2407:c00:4b::c2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
5. 2407:c00:1:4::1 - Colombo, Sri Lanka - Mobitel Pvt Ltd
6. 2407:c00:1:5::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
7. 2001:218:4000:5000::2cd - Tokyo, Japan - NTT Ltd Japan Corporation
8. 2001:218:0:2000::1ad - Tokyo, Japan - NTT Ltd Japan Corporation
9. 2001:218:0:2000::86 - Tokyo, Japan - NTT Ltd Japan Corporation
10. 2001:1900:7:3::101 - California, USA - Level 3 Communications Inc
11. 2001:1900:2::3:83 - California, USA - Level 3 Communications Inc
12. 2001:1900:5:2:2:0:110:1e2 - Louisiana, USA - Level 3 Communications Inc
13. 2001:630:0:10::39 - London, UK - JISC Services Limited
14. 2001:630:0:10::2e - London, UK - JISC Services Limited
15. 2001:630:0:10::1e5 - London, UK - JISC Services Limited
16. 2001:630:0:10::272 - London, UK - JISC Services Limited
17. 2001:630:0:8014::a - London, UK - JISC Services Limited
18. 2001:630:210:321::1 - Cambridge, UK - JISC Services Limited
19. 2001:630:210:318::2 - Cambridge, UK - JISC Services Limited
20. 2001:630:210:2000::2 - Cambridge, UK - JISC Services Limited
21. 2a05:b400:5:ff01::2 - Cambridge, UK - The Chancellor Masters & Scholars of the University of Cambridge
22. 2a05:b400:5:ff11::2 - Cambridge, UK - The Chancellor Masters & Scholars of the University of Cambridge
23. 2a05:b400:5:270::80e8:8408 - Cambridge, UK - The Chancellor Masters & Scholars of the University of Cambridge

- **www5.usp.br**

```

C:\Users\Namina Wijetunga>ping www5.usp.br

Pinging www5.usp.br [2001:12d0:c000:91::54] with 32 bytes of data:
Reply from 2001:12d0:c000:91::54: time=382ms
Reply from 2001:12d0:c000:91::54: time=437ms
Reply from 2001:12d0:c000:91::54: time=377ms
Reply from 2001:12d0:c000:91::54: time=496ms

Ping statistics for 2001:12d0:c000:91::54:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 377ms, Maximum = 496ms, Average = 423ms

C:\Users\Namina Wijetunga>tracert www5.usp.br

Tracing route to www5.usp.br [2001:12d0:c000:91::54]
over a maximum of 30 hops:

  0  1 ms    1 ms    1 ms  2407:c00:e004:2d8b:603a:7aff:fea9:cb8a
  1  *      *      *      Request timed out.
  2  *      *      *      Request timed out.
  3  56 ms   46 ms   47 ms  2407:c00:4b::1
  4  58 ms   58 ms   67 ms  2407:c00:4b::c2
  5  64 ms   57 ms   47 ms  2407:c00:1:4::1
  6  53 ms   57 ms   67 ms  2001:df4:1b00:a002::
  7  *      *      *      Request timed out.
  8  *      *      *      Request timed out.
  9  *      *      *      Request timed out.
 10 *      234 ms 494 ms  e0-34.core2.man1.he.net [2001:470:0:40f::2]
 11 324 ms 237 ms 237 ms  e0-34.core2.dub1.he.net [2001:470:0:387::2]
 12 *      *      *      Request timed out.
 13 *      *      *      Request timed out.
 14 *      483 ms *      e0-35.core3.sao1.he.net [2001:470:0:52d::2]
 15 393 ms 397 ms 477 ms  as28571.saopaulo.sp.ix.br [2001:12f8::220:3]
 16 417 ms 479 ms 475 ms  2001:12d0:840::12
 17 430 ms 385 ms 408 ms  www5.usp.br [2001:12d0:c000:91::54]

Trace complete.

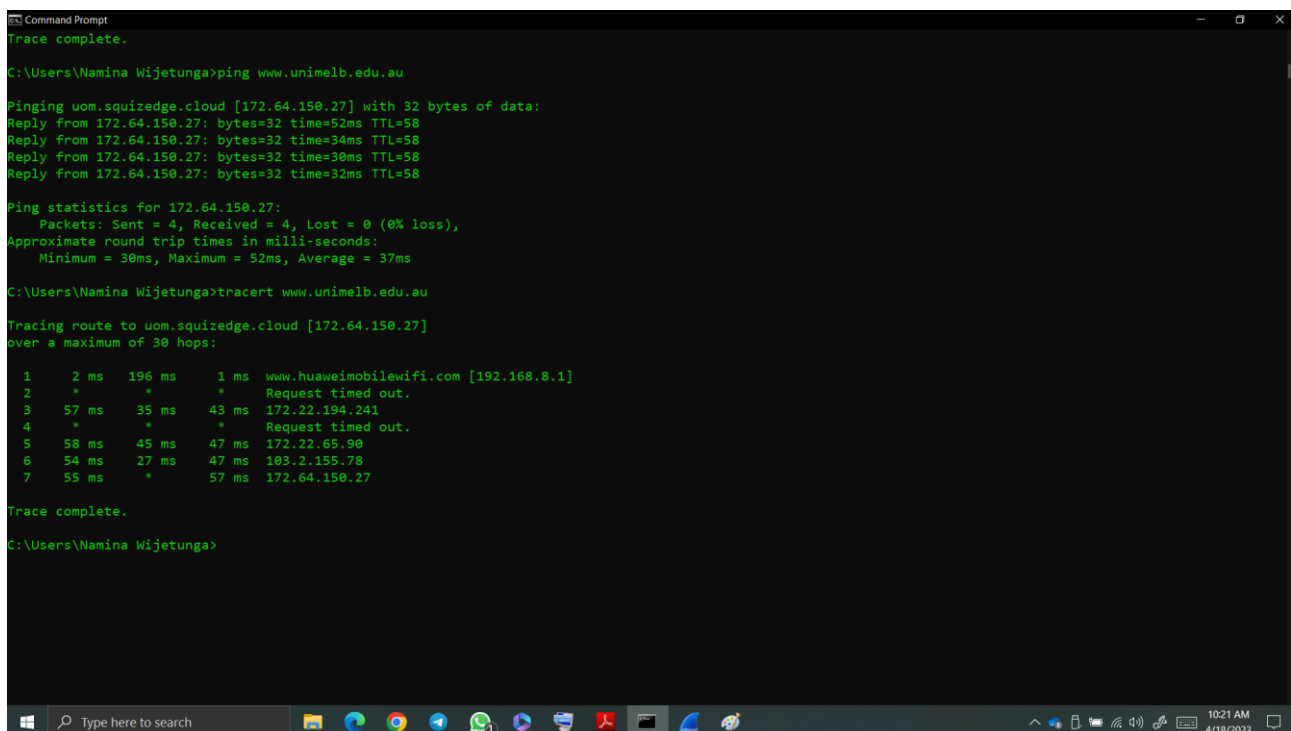
C:\Users\Namina Wijetunga>

```

Using the IP address geolocator,

1. 2407:c00:e004:2d8b:603a:7aff:fea9:cb8a - Jaffna, Sri Lanka - Mobitel Pvt Ltd
2. 2407:c00:4b::2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
3. 2407:c00:4b::c2 - Colombo, Sri Lanka - Mobitel Pvt Ltd
4. 2407:c00:1:4::1 - Colombo, Sri Lanka - Mobitel Pvt Ltd
5. 2001:df4:1b00:a002:: - Colombo, Sri Lanka - Sri Lanka Telecom PLC
6. 2001:470:0:40f::2 - California, USA - Hurricane Electric LLC
7. 2001:470:0:387::2 - California, USA - Hurricane Electric LLC
8. 2001:470:0:52d::2 - California, USA - Hurricane Electric LLC
9. 2001:12f8::220:3 - São Paulo, Brazil - Núcleo de Inf. e Coord. do Ponto BR - NIC.BR
10. 2001:12d0:840::12 - São Paulo, Brazil - Universidade De SAO Paulo
11. 2001:12d0:c000:91::54 - São Paulo, Brazil - Universidade De SAO Paulo

- **[www.unimelb.edu.au](http://www.unimelb.edu.au)**



```
Command Prompt
Trace complete.

C:\Users\Namina Wijetunga>ping www.unimelb.edu.au

Pinging uom.squizedge.cloud [172.64.150.27] with 32 bytes of data:
Reply from 172.64.150.27: bytes=32 time=52ms TTL=58
Reply from 172.64.150.27: bytes=32 time=34ms TTL=58
Reply from 172.64.150.27: bytes=32 time=30ms TTL=58
Reply from 172.64.150.27: bytes=32 time=32ms TTL=58

Ping statistics for 172.64.150.27:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 30ms, Maximum = 52ms, Average = 37ms

C:\Users\Namina Wijetunga>tracert www.unimelb.edu.au

Tracing route to uom.squizedge.cloud [172.64.150.27]
over a maximum of 30 hops:

  0  2 ms  196 ms  1 ms  www.huaweimobilewifi.com [192.168.8.1]
  1  *      *      *      Request timed out.
  2  57 ms  35 ms  43 ms  172.22.194.241
  3  *      *      *      Request timed out.
  4  58 ms  45 ms  47 ms  172.22.65.90
  5  54 ms  27 ms  47 ms  103.2.155.78
  6  55 ms  *      57 ms  172.64.150.27

Trace complete.

C:\Users\Namina Wijetunga>
```

Using the IP address geolocator,

1. 192.168.8.1
2. 172.22.194.241
3. 172.22.65.90
4. 103.2.155.78
5. 172.64.150.27

No information about the location could be obtained.



II. Analysing what happens during web page loading, ping and traceroute by observing the packet details in each of the Layers Within Wireshark captured packets

- Web page loading

The protocols involved in loading a web page include HTTP (Hypertext Transfer Protocol), TCP (Transmission Control Protocol), and DNS (Domain Name System).

The browser first needs to find the IP address of the web server hosting the website that want to access. It sends a DNS request to a DNS server to translate the domain name in the URL into an IP address.

Once the browser has the IP address, it establishes a TCP connection with the web server. This involves a three-way handshake process where the browser and server exchange messages to confirm that they can communicate with each other. The browser then sends an HTTP request to the server asking for the web page content. The server responds with an HTTP response that includes the requested web page content.

- Ping -

When the ping packet is sent, it contains a header with information about the sender, recipient, and the packet itself. The recipient device receives the packet, processes it, and sends a response packet back to the sender, indicating that it has received the packet and how long it took to process.

- Traceroute -

Traceroute program sends a series of packets with incrementally increasing time-to-live (TTL) values. The TTL value is decremented each time the packet passes through a router, and if the TTL reaches 0, the router drops the packet and sends an ICMP (Internet Control Message Protocol) error message back to the sender.

It records the information from the ICMP messages and displays it in a table or graph, showing the path that the packets took from the source to the destination.

III. Why do you get "\*" \* \*" instead of IP addresses for some steps in traceroute?

Explanation -

This occurs when the network device that is responsible for the ongoing hop does not respond to the traceroute request. It can

happen due hardware issues of the network device, the network devices being too busy to respond, or the network device can be programmed so that the ICMP requests in can handle are limited. Therefore, some ICP requests can be dropped.

c) What does the PING indicate?

Explanation - PING indicates the connectivity between the sending and receiving devices of a network and determine the latency, or time delay, of the connection.

I. **Theoretical round trip time** to each from the current location

$$\text{Theoretical Round Trip Time} = \frac{\text{Distance}}{\text{Speed of Light}} \times 2$$

The location where the practical was conducted was Trincomalee, Sri Lanka. Assume that the speed of light in a vacuum is 299,792.458 km/s.

- **www.ruh.ac.lk**

Approximate distance to University of Ruhuna from Trincomalee - 399 km

Theoretical Round Trip Time - 2.6618 ms

- **www.uoregon.edu**

Approximate distance to University of Oregon from Trincomalee - 15,414 km

Theoretical Round Trip Time - 102.8311 ms

- **www.keio.ac.jp**

Approximate distance to Keio University from Trincomalee - 5,945 km

Theoretical Round Trip Time - 39.6608 ms

- **Japan.go.jp**

Approximate distance to Tokyo from Trincomalee - 6,620 km

Theoretical Round Trip Time - 44.1639 ms

- **nsf.gov**

Approximate distance to National Science Foundation, Virginia from Trincomalee - 14,900 km

Theoretical Round Trip Time - 99.4021 ms

- **www.cam.ac.uk**

Approximate distance to University of Cambridge from Trincomalee - 9,385 km

Theoretical Round Trip Time - 62.0998 ms

- **www5.usp.br**

Approximate distance to University of San Paulo, Brazil from Trincomalee - 18,065 km

Theoretical Round Trip Time - 120.5167 ms

- **www.unimelb.edu.au**

Approximate distance to University of Melbourne from Trincomalee - 6,875 km

Theoretical Round Trip Time - 45.8651 ms

## II. Comparison of the Theoretical Round Trip Time and the measured Ping Time

	Theoretical round trip time (in milliseconds)	Measured average ping time (in milliseconds)
www.ruh.ac.lk	2.6618	Request timed out
www.uoregon.edu	102.8311	97
www.keio.ac.jp	39.6608	141
Japan.go.jp	44.1639	132
nsf.gov	99.4021	348
www.cam.ac.uk	62.0998	309
www5.usp.br	120.5167	423
www.unimelb.edu.au	45.8651	37

Explanation -

- The actual route travelled by the packets is not a straight line and they are undergoing so many processes on the way to the destination.
- More the number of devices they have to go through (Examples such as switches, routers) more processes will happen, and more processing delays will encounter.
- Additionally, the speed of light inside the fibre is less than the speed of light inside a vacuum which will take more time to reach the destination.

## III. Can you identify sub-components that contribute to PING time?

- Quality of the ISP.
- Speed of the Internet connection.
- Firewall configuration.

- Geographical location.
- Bandwidth.

## Question (2) - Why is bandwidth (throughput) important?

Explanation -

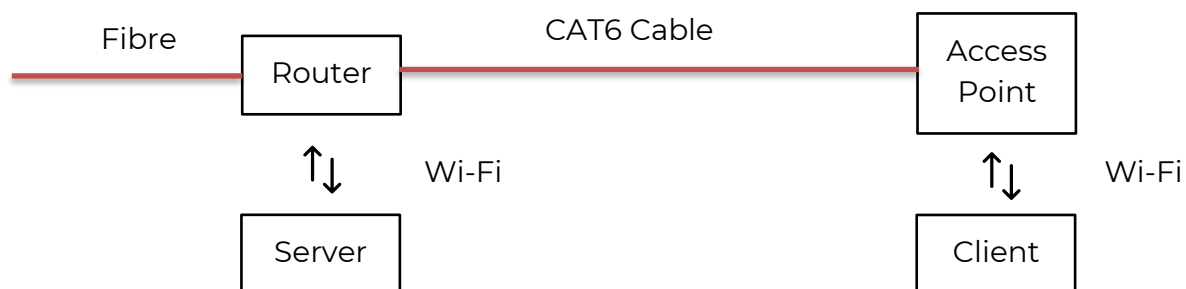
- Bandwidth is a measure of the amount of data that can be transmitted over a network in a given time period.
- Higher the bandwidth, more data can be transmitted, and it is important when multiple devices are trying to access the same Wi-Fi or Hotspot.
- It will reduce the latency which will reduce the response time for a given request.
- But increasing the bandwidth causes the cost of the network to increase as well.
- Therefore, it is important to manage the bandwidth when designing a efficient and a user friendly network.

## Performing iperf3 bandwidth test

- During Off-Peak Traffic Time

### I. At Home

- Client & Server Connected to The Same Network



IP Address - 192.168.1.8

IP Address - 192.168.4.240

```

Server listening on 5201
Accepted connection from 192.168.1.7, port 6902
[ 5] local 192.168.1.8 port 5201 connected to 192.168.1.7 port 6903
[ ID] Interval      Transfer      Bandwidth
[ 5] 0.00-1.00 sec  8.20 MBytes  68.8 Mbits/sec
[ 5] 1.00-2.00 sec  8.79 MBytes  73.7 Mbits/sec
[ 5] 2.00-3.00 sec  8.29 MBytes  69.5 Mbits/sec
[ 5] 3.00-4.00 sec  7.56 MBytes  63.4 Mbits/sec
[ 5] 4.00-5.00 sec  7.19 MBytes  60.3 Mbits/sec
[ 5] 5.00-6.00 sec  7.92 MBytes  66.4 Mbits/sec
[ 5] 6.00-7.00 sec  8.17 MBytes  68.5 Mbits/sec
[ 5] 7.00-8.01 sec  7.91 MBytes  65.8 Mbits/sec
[ 5] 8.01-9.00 sec  8.36 MBytes  70.7 Mbits/sec
[ 5] 9.00-10.00 sec  8.49 MBytes  71.2 Mbits/sec
[ 5] 10.00-10.07 sec  478 KBytes  60.2 Mbits/sec
[ ID] Interval      Transfer      Bandwidth
[ 5] 0.00-10.07 sec  0.00 Bytes    0.00 bits/sec
[ 5] 0.00-10.07 sec  81.3 MBytes  67.8 Mbits/sec
Server listening on 5201
  
```

Results at the Server

```

C:\Users\Namina Wijetunga\Downloads\A>iperf3.exe -c 192.168.1.8
Connecting to host 192.168.1.8, port 5201
[ 4] local 192.168.1.7 port 6903 connected to 192.168.1.8 port 5201
[ ID] Interval      Transfer      Bandwidth
[ 4] 0.00-1.00 sec  8.75 MBytes  73.1 Mbits/sec
[ 4] 1.00-2.00 sec  8.75 MBytes  73.6 Mbits/sec
[ 4] 2.00-3.01 sec  8.12 MBytes  67.8 Mbits/sec
[ 4] 3.01-4.01 sec  7.62 MBytes  63.9 Mbits/sec
[ 4] 4.01-5.00 sec  7.25 MBytes  61.2 Mbits/sec
[ 4] 5.00-6.00 sec  7.88 MBytes  66.0 Mbits/sec
[ 4] 6.00-7.01 sec  8.25 MBytes  68.8 Mbits/sec
[ 4] 7.01-8.01 sec  7.88 MBytes  66.1 Mbits/sec
[ 4] 8.01-9.00 sec  8.38 MBytes  70.6 Mbits/sec
[ 4] 9.00-10.00 sec  8.50 MBytes  71.4 Mbits/sec
[ ID] Interval      Transfer      Bandwidth
[ 4] 0.00-10.00 sec  81.4 MBytes  68.3 Mbits/sec
[ 4] 0.00-10.00 sec  81.3 MBytes  68.2 Mbits/sec
iperf Done.
C:\Users\Namina Wijetunga\Downloads\A>
  
```

Results at the Client

## Public Servers

```
C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c iperf.astra.in.ua -p 5203
Connecting to host iperf.astra.in.ua, port 5203
[ 4] local 192.168.4.240 port 11941 connected to 193.93.216.52 port 5203
[ ID] Interval           Transfer     Bandwidth
[ 4]  0.00-1.01   sec      256 KBytes    2.08 Mbits/sec
[ 4]  1.01-2.01   sec      512 KBytes    4.20 Mbits/sec
[ 4]  2.01-3.00   sec     1.00 MBytes    8.43 Mbits/sec
[ 4]  3.00-4.01   sec      768 KBytes    6.25 Mbits/sec
[ 4]  4.01-5.01   sec      640 KBytes    5.25 Mbits/sec
[ 4]  5.01-6.01   sec      640 KBytes    5.24 Mbits/sec
[ 4]  6.01-7.00   sec      512 KBytes    4.22 Mbits/sec
[ 4]  7.00-8.01   sec      640 KBytes    5.18 Mbits/sec
[ 4]  8.01-9.01   sec      640 KBytes    5.28 Mbits/sec
[ 4]  9.01-10.01  sec      640 KBytes    5.24 Mbits/sec
- - - - -
[ ID] Interval           Transfer     Bandwidth
[ 4]  0.00-10.01  sec     6.12 MBytes    5.13 Mbits/sec    sender
[ 4]  0.00-10.01  sec     6.11 MBytes    5.13 Mbits/sec    receiver

iperf Done.

C:\Users\Namina Wijetunga\Downloads\A>
```

```
C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c iperf.biznetnetworks.com -p 5203
Connecting to host iperf.biznetnetworks.com, port 5203
[ 4] local 192.168.4.240 port 11850 connected to 117.102.109.186 port 5203
[ ID] Interval           Transfer     Bandwidth
[ 4]  0.00-1.01   sec      256 KBytes    2.08 Mbits/sec
[ 4]  1.01-2.01   sec      256 KBytes    2.10 Mbits/sec
[ 4]  2.01-3.01   sec      640 KBytes    5.25 Mbits/sec
[ 4]  3.01-4.00   sec      512 KBytes    4.20 Mbits/sec
[ 4]  4.00-5.02   sec      384 KBytes    3.11 Mbits/sec
[ 4]  5.02-6.01   sec      512 KBytes    4.22 Mbits/sec
[ 4]  6.01-7.01   sec      640 KBytes    5.25 Mbits/sec
[ 4]  7.01-8.01   sec      512 KBytes    4.19 Mbits/sec
[ 4]  8.01-9.01   sec      512 KBytes    4.20 Mbits/sec
[ 4]  9.01-10.01  sec      640 KBytes    5.24 Mbits/sec
- - - - -
[ ID] Interval           Transfer     Bandwidth
[ 4]  0.00-10.01  sec     4.75 MBytes    3.98 Mbits/sec    sender
[ 4]  0.00-10.01  sec     4.67 MBytes    3.92 Mbits/sec    receiver

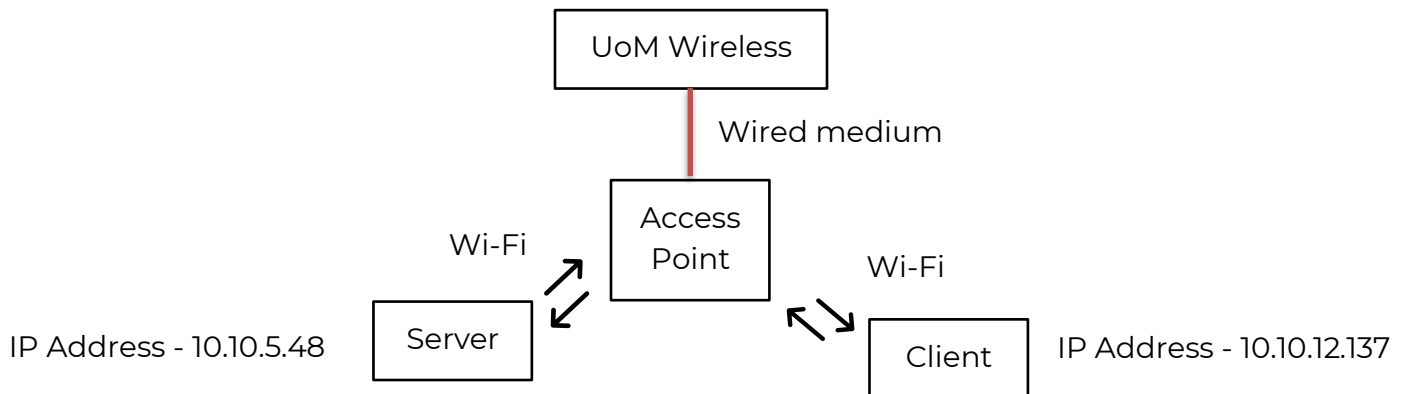
iperf Done.
```

```
Command Prompt
C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c speedtest.uztelecom.uz -p 5203
Connecting to host speedtest.uztelecom.uz, port 5203
[ 4] local 192.168.4.240 port 11906 connected to 195.69.189.215 port 5203
[ ID] Interval           Transfer     Bandwidth
[ 4]  0.00-1.01   sec      384 KBytes    3.13 Mbits/sec
[ 4]  1.01-2.01   sec     1.00 MBytes    8.34 Mbits/sec
[ 4]  2.01-3.01   sec     1.00 MBytes    8.39 Mbits/sec
[ 4]  3.01-4.00   sec     1.12 MBytes    9.51 Mbits/sec
[ 4]  4.00-5.00   sec      768 KBytes    6.30 Mbits/sec
[ 4]  5.00-6.01   sec      256 KBytes    2.07 Mbits/sec
[ 4]  6.01-7.01   sec      256 KBytes    2.11 Mbits/sec
[ 4]  7.01-8.01   sec      128 KBytes    1.05 Mbits/sec
[ 4]  8.01-9.00   sec      256 KBytes    2.10 Mbits/sec
[ 4]  9.00-10.00  sec      256 KBytes    2.10 Mbits/sec
- - - - -
[ ID] Interval           Transfer     Bandwidth
[ 4]  0.00-10.00  sec     5.38 MBytes    4.51 Mbits/sec    sender
[ 4]  0.00-10.00  sec     5.27 MBytes    4.42 Mbits/sec    receiver

iperf Done.
```

## II. At University of Moratuwa

### ▪ Client & Server Connected to The Same Network



```
C:\Windows\System32\cmd.exe - iperf3.exe -s
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 5] 0.00-10.04 sec  0.00 Bytes  0.00 bits/sec
[ 5] 0.00-10.04 sec  12.1 MBytes 10.1 Mbits/sec
-----
Server listening on 5201
Accepted connection from 10.10.12.137, port 12583
[ 5] local 10.10.5.48 port 5201 connected to 10.10.12.137 port 12584
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 5] 0.00-1.01 sec  3.26 MBytes 27.2 Mbits/sec
[ 5] 1.01-2.01 sec  3.60 MBytes 30.2 Mbits/sec
[ 5] 2.01-3.00 sec  2.10 MBytes 17.7 Mbits/sec
[ 5] 3.00-4.01 sec  3.09 MBytes 25.8 Mbits/sec
[ 5] 4.01-5.00 sec  3.53 MBytes 29.8 Mbits/sec
[ 5] 5.00-6.00 sec  3.40 MBytes 29.1 Mbits/sec
[ 5] 6.00-7.00 sec  4.00 MBytes 33.7 Mbits/sec
[ 5] 7.00-8.00 sec  4.05 MBytes 34.0 Mbits/sec
[ 5] 8.00-9.00 sec  3.45 MBytes 28.8 Mbits/sec
[ 5] 9.00-10.00 sec 3.81 MBytes 32.0 Mbits/sec
[ 5] 10.00-10.05 sec 133 KBytes 23.1 Mbits/sec
-----
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 5] 0.00-10.05 sec  0.00 Bytes  0.00 bits/sec
[ 5] 0.00-10.05 sec  34.5 MBytes 28.8 Mbits/sec
-----
Server listening on 5201
```

Results at the Server

```
Command Prompt
C:\Users\Namina Wijetunga\Downloads\A>iperf3.exe -c 10.10.5.48
Connecting to host 10.10.5.48, port 5201
[ 4] local 10.10.12.137 port 12584 connected to 10.10.5.48 port 5201
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 4] 0.00-1.00 sec  3.50 MBytes 29.3 Mbits/sec
[ 4] 1.00-2.01 sec  3.50 MBytes 29.3 Mbits/sec
[ 4] 2.01-3.00 sec  2.25 MBytes 18.9 Mbits/sec
[ 4] 3.00-4.01 sec  3.00 MBytes 25.1 Mbits/sec
[ 4] 4.01-5.01 sec  3.62 MBytes 30.4 Mbits/sec
[ 4] 5.01-6.01 sec  3.50 MBytes 29.3 Mbits/sec
[ 4] 6.01-7.00 sec  3.88 MBytes 32.8 Mbits/sec
[ 4] 7.00-8.00 sec  4.12 MBytes 34.6 Mbits/sec
[ 4] 8.00-9.00 sec  3.38 MBytes 28.3 Mbits/sec
[ 4] 9.00-10.01 sec 3.75 MBytes 31.3 Mbits/sec
-----
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 4] 0.00-10.01 sec 34.5 MBytes 28.9 Mbits/sec
[ 4] 0.00-10.01 sec 34.5 MBytes 28.9 Mbits/sec
-----
iperf Done.
C:\Users\Namina Wijetunga\Downloads\A>_
```

Results at the Client

### ▪ Public Servers

```
C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c iperf.astra.in.ua -p 5202
Connecting to host iperf.astra.in.ua, port 5202
[ 4] local 2401:dd00:10:20:c08b:ea52:6a5e:9755 port 4673 connected to 2a10:2f40:1::aa port 5202
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 4] 0.00-1.01 sec  256 KBytes  2.09 Mbits/sec
[ 4] 1.01-2.00 sec  128 KBytes  1.05 Mbits/sec
[ 4] 2.00-3.02 sec  384 KBytes  3.10 Mbits/sec
[ 4] 3.02-4.00 sec  640 KBytes  5.32 Mbits/sec
[ 4] 4.00-5.01 sec  640 KBytes  5.20 Mbits/sec
[ 4] 5.01-6.00 sec  768 KBytes  6.33 Mbits/sec
[ 4] 6.00-7.01 sec  768 KBytes  6.22 Mbits/sec
[ 4] 7.01-8.01 sec  512 KBytes  4.21 Mbits/sec
[ 4] 8.01-9.00 sec  512 KBytes  4.22 Mbits/sec
[ 4] 9.00-10.00 sec  384 KBytes  3.16 Mbits/sec
-----
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 4] 0.00-10.00 sec  4.88 MBytes  4.09 Mbits/sec
[ 4] 0.00-10.00 sec  4.87 MBytes  4.09 Mbits/sec
-----
iperf Done.
C:\Users\Namina Wijetunga\Downloads\A>_
```

```
C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c speedtest.uztelecom.uz -p 5202
Connecting to host speedtest.uztelecom.uz, port 5202
[ 4] local 2401:dd00:10:20:c08b:ea52:6a5e:9755 port 4653 connected to 2a05:45c7:f000:100::215 port 5202
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 4] 0.00-1.01 sec  256 KBytes  2.08 Mbits/sec
[ 4] 1.01-2.01 sec  512 KBytes  4.21 Mbits/sec
[ 4] 2.01-3.01 sec  896 KBytes  7.30 Mbits/sec
[ 4] 3.01-4.01 sec  640 KBytes  5.27 Mbits/sec
[ 4] 4.01-5.00 sec  896 KBytes  7.37 Mbits/sec
[ 4] 5.00-6.00 sec  512 KBytes  4.20 Mbits/sec
[ 4] 6.00-7.01 sec  768 KBytes  6.23 Mbits/sec
[ 4] 7.01-8.00 sec  896 KBytes  7.39 Mbits/sec
[ 4] 8.00-9.01 sec  768 KBytes  6.25 Mbits/sec
[ 4] 9.01-10.01 sec  640 KBytes  5.26 Mbits/sec
-----
[ ID] Interval      Transfer    Bandwidth        sender receiver
[ 4] 0.00-10.01 sec  6.62 MBytes  5.55 Mbits/sec
[ 4] 0.00-10.01 sec  6.62 MBytes  5.55 Mbits/sec
-----
iperf Done.
```

- During Peak Traffic Time

## I. At Home

- Client & Server Connected to The Same Network

```

Command Prompt - iperf3.exe -s
C:\Users\Asus\Downloads>A>iperf3.exe -s
Server listening on 5201
Accepted connection from 192.168.1.7, port 6896
[ 5] local 192.168.1.8 port 5201 connected to 192.168.1.7 port 6897
[ ID] Interval      Transfer    Bandwidth
[ 5]  0.00-1.00  sec    4.89 MBytes  41.1 Mbits/sec
[ 5]  1.00-2.00  sec    6.09 MBytes  51.0 Mbits/sec
[ 5]  2.00-3.00  sec    7.26 MBytes  61.0 Mbits/sec
[ 5]  3.00-4.00  sec    8.08 MBytes  67.8 Mbits/sec
[ 5]  4.00-5.00  sec    8.55 MBytes  71.7 Mbits/sec
[ 5]  5.00-6.00  sec    8.54 MBytes  71.6 Mbits/sec
[ 5]  6.00-7.00  sec    8.25 MBytes  69.3 Mbits/sec
[ 5]  7.00-8.00  sec    8.09 MBytes  67.7 Mbits/sec
[ 5]  8.00-9.00  sec    8.39 MBytes  70.3 Mbits/sec
[ 5]  9.00-10.00 sec    8.37 MBytes  70.4 Mbits/sec
[ 5] 10.00-10.04 sec    364 KBytes  69.1 Mbits/sec
[ ID] Interval      Transfer    Bandwidth
[ 5]  0.00-10.04 sec    0.00 Bytes  0.00 bits/sec
[ 5]  0.00-10.04 sec    76.9 MBytes  64.2 Mbits/sec
sender
receiver
iperf Done.

```

Results at the Server

```

Command Prompt
C:\Users\Namina Wijetunga\Downloads>A>iperf3.exe -c 192.168.1.8
Connecting to host 192.168.1.8, port 5201
[ 4] local 192.168.1.7 port 6897 connected to 192.168.1.8 port 5201
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-1.01  sec    5.12 MBytes  42.6 Mbits/sec
[ 4]  1.01-2.01  sec    6.25 MBytes  52.7 Mbits/sec
[ 4]  2.01-3.01  sec    7.25 MBytes  60.8 Mbits/sec
[ 4]  3.01-4.01  sec    8.00 MBytes  67.1 Mbits/sec
[ 4]  4.01-5.01  sec    8.50 MBytes  71.3 Mbits/sec
[ 4]  5.01-6.00  sec    8.62 MBytes  72.6 Mbits/sec
[ 4]  6.00-7.00  sec    8.25 MBytes  69.5 Mbits/sec
[ 4]  7.00-8.01  sec    8.00 MBytes  66.6 Mbits/sec
[ 4]  8.01-9.01  sec    8.38 MBytes  70.3 Mbits/sec
[ 4]  9.01-10.00 sec    8.50 MBytes  71.7 Mbits/sec
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-10.00 sec    76.9 MBytes  64.5 Mbits/sec
[ 4]  0.00-10.00 sec    76.9 MBytes  64.5 Mbits/sec
sender
receiver
iperf Done.

```

Results at the Client

- Public Servers

```

C:\Users\Namina Wijetunga\Downloads>A>iperf3 -c iperf.astra.in.ua -p 5202
Connecting to host iperf.astra.in.ua, port 5202
[ 4] local 192.168.4.240 port 7208 connected to 193.93.216.52 port 5202
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-1.01  sec    256 KBytes  2.08 Mbits/sec
[ 4]  1.01-2.01  sec    256 KBytes  2.10 Mbits/sec
[ 4]  2.01-3.01  sec    640 KBytes  5.22 Mbits/sec
[ 4]  3.01-4.00  sec    512 KBytes  4.23 Mbits/sec
[ 4]  4.00-5.00  sec    640 KBytes  5.26 Mbits/sec
[ 4]  5.00-6.01  sec    640 KBytes  5.19 Mbits/sec
[ 4]  6.01-7.01  sec    384 KBytes  3.16 Mbits/sec
[ 4]  7.01-8.01  sec    512 KBytes  4.20 Mbits/sec
[ 4]  8.01-9.00  sec    512 KBytes  4.21 Mbits/sec
[ 4]  9.00-10.01 sec    512 KBytes  4.15 Mbits/sec
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-10.01 sec    4.75 MBytes  3.98 Mbits/sec
[ 4]  0.00-10.01 sec    4.72 MBytes  3.96 Mbits/sec
sender
receiver
iperf Done.

```

```

C:\Users\Namina Wijetunga\Downloads>A>iperf3 -c iperf.biznetnetworks.com -p 5202
Connecting to host iperf.biznetnetworks.com, port 5202
[ 4] local 192.168.4.240 port 7896 connected to 117.102.109.186 port 5202
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-1.00  sec    256 KBytes  2.10 Mbits/sec
[ 4]  1.00-2.01  sec    128 KBytes  1.04 Mbits/sec
[ 4]  2.01-3.01  sec    256 KBytes  2.09 Mbits/sec
[ 4]  3.01-4.01  sec    256 KBytes  2.10 Mbits/sec
[ 4]  4.01-5.01  sec    384 KBytes  3.14 Mbits/sec
[ 4]  5.01-6.00  sec    256 KBytes  2.12 Mbits/sec
[ 4]  6.00-7.01  sec    128 KBytes  1.04 Mbits/sec
[ 4]  7.01-8.01  sec    384 KBytes  3.12 Mbits/sec
[ 4]  8.01-9.00  sec    128 KBytes  1.06 Mbits/sec
[ 4]  9.00-10.01 sec    256 KBytes  2.07 Mbits/sec
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-10.01 sec    2.38 MBytes  1.99 Mbits/sec
[ 4]  0.00-10.01 sec    2.18 MBytes  1.83 Mbits/sec
sender
receiver
iperf Done.

```

```

C:\Users\Namina Wijetunga\Downloads>A>iperf3 -c speedtest.uztelecom.uz -p 5202
iperf3: error - the server is busy running a test. try again later

C:\Users\Namina Wijetunga\Downloads>A>iperf3 -c speedtest.uztelecom.uz -p 5202
Connecting to host speedtest.uztelecom.uz, port 5202
[ 4] local 192.168.4.240 port 7306 connected to 195.69.189.215 port 5202
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-1.01  sec    256 KBytes  2.07 Mbits/sec
[ 4]  1.01-2.00  sec    640 KBytes  5.29 Mbits/sec
[ 4]  2.00-3.01  sec    896 KBytes  7.27 Mbits/sec
[ 4]  3.01-4.01  sec    640 KBytes  5.23 Mbits/sec
[ 4]  4.01-5.00  sec    768 KBytes  6.34 Mbits/sec
[ 4]  5.00-6.00  sec    640 KBytes  5.25 Mbits/sec
[ 4]  6.00-7.00  sec    384 KBytes  3.15 Mbits/sec
[ 4]  7.00-8.00  sec    512 KBytes  4.20 Mbits/sec
[ 4]  8.00-9.01  sec    384 KBytes  3.10 Mbits/sec
[ 4]  9.01-10.01 sec    512 KBytes  4.20 Mbits/sec
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-10.01 sec    5.50 MBytes  4.61 Mbits/sec
[ 4]  0.00-10.01 sec    5.44 MBytes  4.56 Mbits/sec
sender
receiver
iperf Done.

```

## II. At University of Moratuwa

### ▪ Client & Server Connected to The Same Network

```
C:\Windows\System32\cmd.exe - iperf3.exe -s

-----
Server listening on 5201
-----
Accepted connection from 10.10.12.137, port 11327
[ 5] local 10.10.5.48 port 5201 connected to 10.10.12.137 port 11328
[ ID] Interval      Transfer    Bandwidth
[ 5]  0.00-1.00  sec    190 KBytes  1.55 Mbits/sec
[ 5]  1.00-2.01  sec     0.00 Bytes  0.00 bits/sec
[ 5]  2.01-3.01  sec     0.00 Bytes  0.00 bits/sec
[ 5]  3.01-4.01  sec     0.00 Bytes  0.00 bits/sec
[ 5]  4.01-5.01  sec     0.00 Bytes  0.00 bits/sec
[ 5]  5.01-6.01  sec     0.00 Bytes  0.00 bits/sec
[ 5]  6.01-7.01  sec     0.00 Bytes  0.00 bits/sec
[ 5]  7.01-8.01  sec    200 KBytes  1.64 Mbits/sec
[ 5]  8.01-9.00  sec     0.00 Bytes  0.00 bits/sec
[ 5]  9.00-10.01 sec     0.00 Bytes  0.00 bits/sec
[ 5] 10.01-11.01 sec     0.00 Bytes  0.00 bits/sec
[ 5] 11.01-12.00 sec     0.00 Bytes  0.00 bits/sec
[ 5] 12.00-12.45 sec     0.00 Bytes  0.00 bits/sec
-----
[ ID] Interval      Transfer    Bandwidth
[ 5]  0.00-12.45  sec     0.00 Bytes  0.00 bits/sec
[ 5]  0.00-12.45  sec    390 KBytes  257 Kbits/sec
-----
iperf Done.
```

Results at the Client

```
C:\Users\Namina Wijetunga\Downloads\A>iperf3.exe -c 10.10.5.48
Connecting to host 10.10.5.48, port 5201
[ 4] local 10.10.12.137 port 11328 connected to 10.10.5.48 port 5201
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-1.01  sec    384 KBytes  3.12 Mbits/sec
[ 4]  1.01-2.01  sec     0.00 Bytes  0.00 bits/sec
[ 4]  2.01-3.00  sec     0.00 Bytes  0.00 bits/sec
[ 4]  3.00-4.00  sec     0.00 Bytes  0.00 bits/sec
[ 4]  4.00-5.01  sec     0.00 Bytes  0.00 bits/sec
[ 4]  5.01-6.00  sec     0.00 Bytes  0.00 bits/sec
[ 4]  6.00-7.01  sec     0.00 Bytes  0.00 bits/sec
[ 4]  7.01-8.00  sec    256 KBytes  2.11 Mbits/sec
[ 4]  8.00-9.01  sec     0.00 Bytes  0.00 bits/sec
[ 4]  9.01-10.00 sec     0.00 Bytes  0.00 bits/sec
-----
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-10.00  sec    640 KBytes  524 Kbits/sec
[ 4]  0.00-10.00  sec    390 KBytes  319 Kbits/sec
-----
iperf Done.
```

Results at the Server

### ▪ Public Servers

```
C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c speedtest.uztelecom.uz -p 5202
Connecting to host speedtest.uztelecom.uz, port 5202
[ 4] local 2401:dd00:10:20:cdab:ea2b:1d81:580d port 13668 connected to 2a05:45c7:f000:100::215 port 5202
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-1.00  sec    256 KBytes  2.09 Mbits/sec
[ 4]  1.00-2.01  sec     0.00 Bytes  0.00 bits/sec
[ 4]  2.01-3.00  sec     0.00 Bytes  0.00 bits/sec
[ 4]  3.00-4.01  sec     0.00 Bytes  0.00 bits/sec
[ 4]  4.01-5.00  sec     0.00 Bytes  0.00 bits/sec
[ 4]  5.00-6.01  sec     0.00 Bytes  0.00 bits/sec
[ 4]  6.01-7.00  sec    512 KBytes  4.24 Mbits/sec
[ 4]  7.00-8.01  sec    128 KBytes  1.04 Mbits/sec
[ 4]  8.01-9.01  sec     0.00 Bytes  0.00 bits/sec
[ 4]  9.01-10.01 sec    256 KBytes  2.09 Mbits/sec
-----
[ ID] Interval      Transfer    Bandwidth
[ 4]  0.00-10.01  sec    1.12 MBytes  943 Kbits/sec
[ 4]  0.00-10.01  sec    1.12 MBytes  943 Kbits/sec
-----
iperf Done.
```



```

C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c iperf.astra.in.ua -p 5202
Connecting to host iperf.astra.in.ua, port 5202
[ 4] local 2401:dd00:10:20:cdab:ea2b:1d81:580d port 13716 connected to 2a10:2f40:1::aa port 5202
[ ID] Interval           Transfer     Bandwidth
[ 4]  0.00-1.01   sec      256 KBytes    2.08 Mbits/sec
[ 4]  1.01-2.01   sec       0.00 Bytes    0.00 bits/sec
[ 4]  2.01-3.01   sec       0.00 Bytes    0.00 bits/sec
[ 4]  3.01-4.01   sec       0.00 Bytes    0.00 bits/sec
[ 4]  4.01-5.00   sec      128 KBytes    1.06 Mbits/sec
[ 4]  5.00-6.01   sec      256 KBytes    2.07 Mbits/sec
[ 4]  6.01-7.00   sec      512 KBytes    4.23 Mbits/sec
[ 4]  7.00-8.01   sec      640 KBytes    5.20 Mbits/sec
[ 4]  8.01-9.01   sec      640 KBytes    5.24 Mbits/sec
[ 4]  9.01-10.02  sec      640 KBytes    5.23 Mbits/sec
-----
[ ID] Interval           Transfer     Bandwidth
[ 4]  0.00-10.02  sec      3.00 MBytes    2.51 Mbits/sec
[ 4]  0.00-10.02  sec      3.00 MBytes    2.51 Mbits/sec
sender
receiver

iperf Done.

```

```

Command Prompt

-T, --title str          prefix every output line with this string
--get-server-output      get results from server
--udp-counters-64bit     use 64-bit counters in UDP test packets

[KMG] indicates options that support a K/M/G suffix for kilo-, mega-, or giga-

iperf3 homepage at: http://software.es.net/iperf/
Report bugs to: https://github.com/esnet/iperf

C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c iperf.biznetnetworks.com -p 5202
iperf3: error - unable to connect to server: Connection timed out

C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c iperf.biznetnetworks.com -p 5203
iperf3: error - unable to connect to server: Connection timed out

C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c iperf.biznetnetworks.com -p 5203
iperf3: error - unable to connect to server: Connection timed out

C:\Users\Namina Wijetunga\Downloads\A>iperf3 -c iperf.biznetnetworks.com -p 5202
iperf3: error - unable to connect to server: Connection timed out

```

### Observations and Comments:

- The bandwidth of the client and server which are connected to the same network is higher than the bandwidth of the public server and the remote client.
- The bandwidth during the peak traffic time is much lesser than the bandwidth during the off-peak traffic time.
- When connected to the network at University of Moratuwa during the peak traffic time, for some public servers, the connection timed out which the reason being too many users in the network trying to access the network at same time.

### Question (3) - Why is latency important?

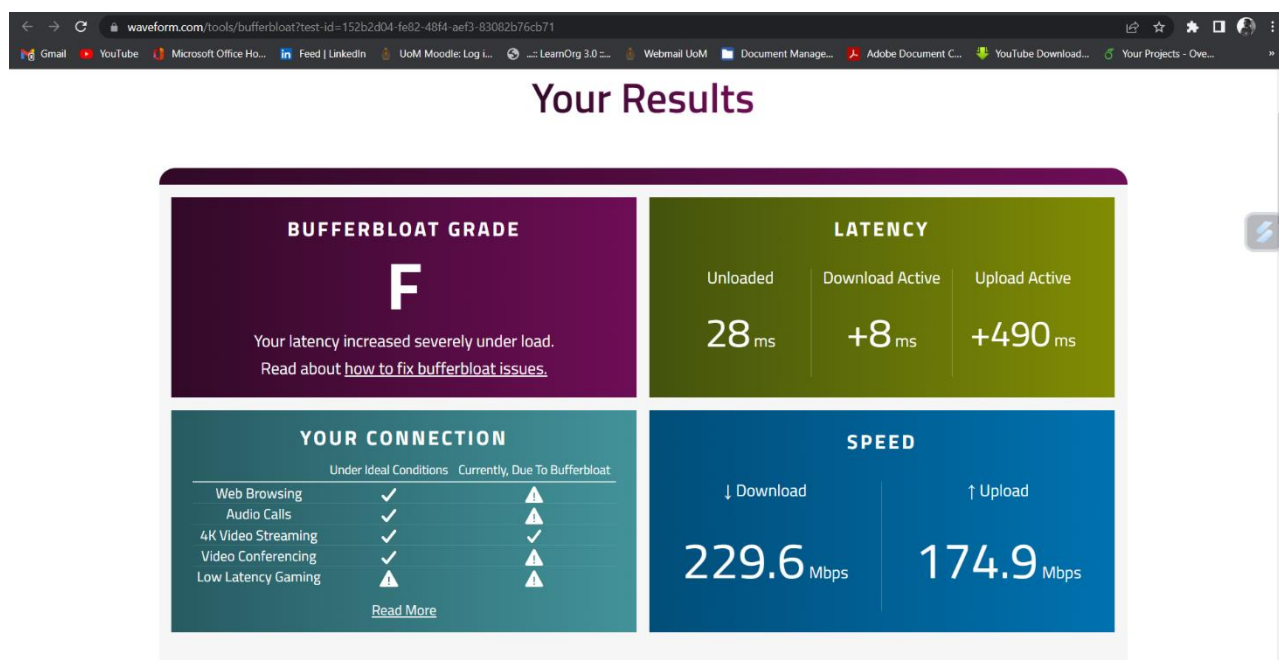
Explanation -

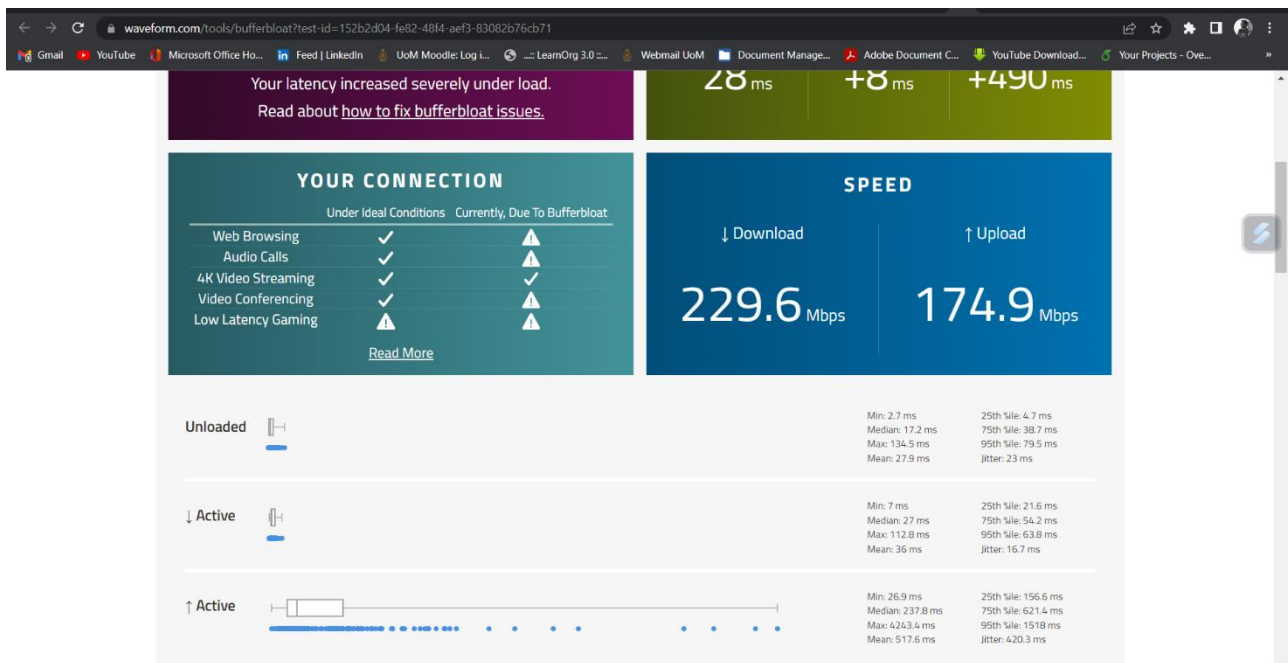
- User experience: In applications that require real-time interaction, such as online gaming or video conferencing, even small amounts of latency can have a noticeable impact on the user experience. Latency can cause delays in voice or video transmission, making conversations or gameplay feel sluggish or unresponsive.
- Network performance: Latency can also affect the overall performance of a network. High latency can lead to slow data transfer rates, packet loss, and network congestion, which can impact the ability of users to access and use network resources.
- Financial transactions: In financial applications, such as trading platforms, even a small delay in data transmission can have significant financial consequences. Latency can impact the accuracy of stock prices and transaction times, which can result in lost profits or other financial impacts.
- Cloud computing: Many cloud-based applications and services rely on low-latency network connections to provide fast and responsive performance. High latency can impact the performance of these applications and make them feel slow or unresponsive.
- SEO: Latency also plays a role in website search engine optimization (SEO). Search engines such as Google consider website speed and responsiveness as part of their ranking algorithms, which means that websites with lower latency are likely to perform better in search results.

### Performing Bufferbloat latency test,

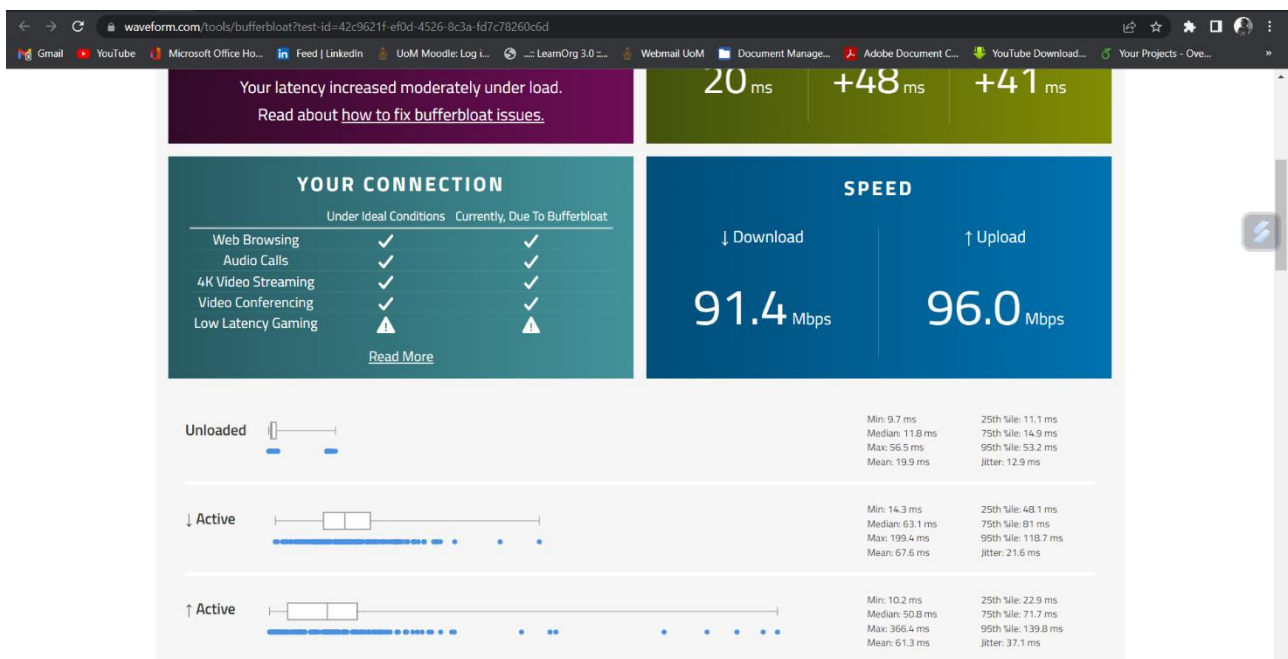
- During Off-Peak Traffic Time

#### I. At University of Moratuwa



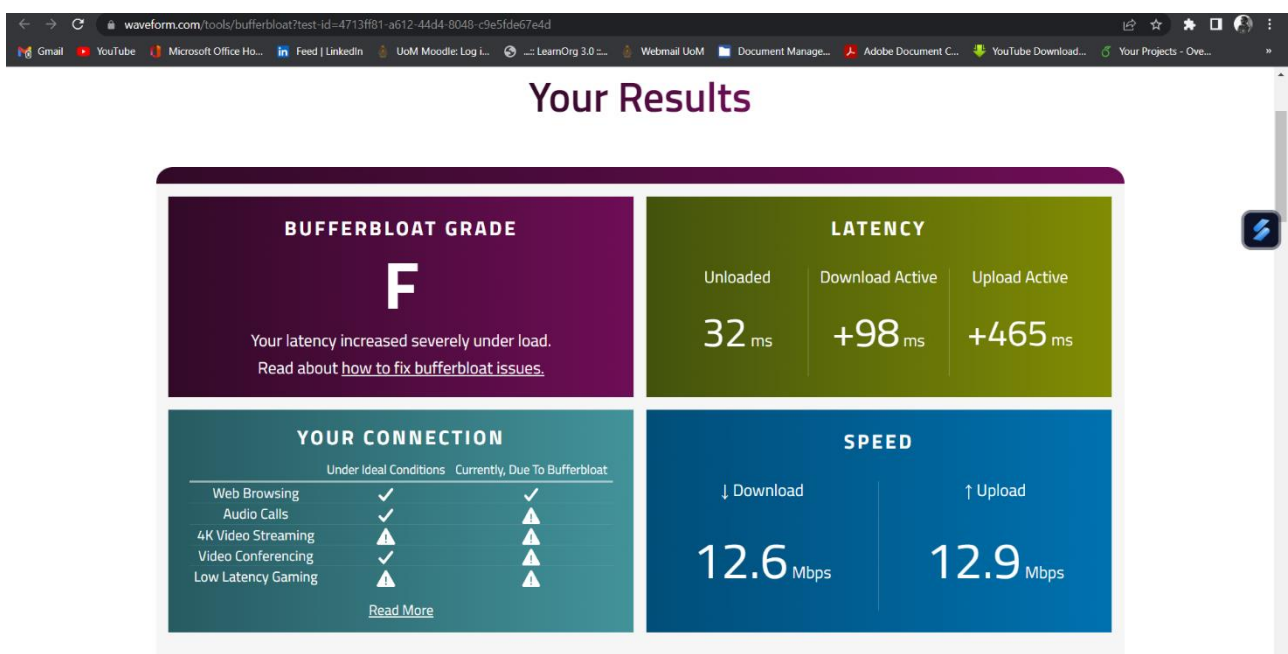


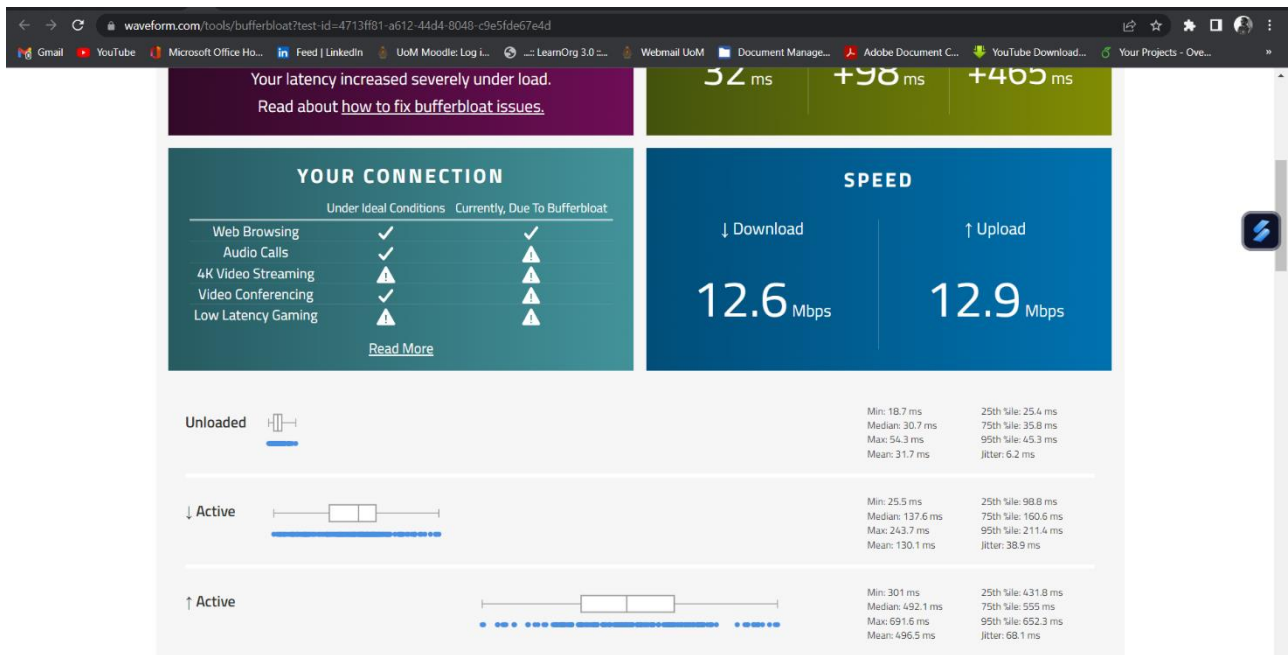
## II. At Home Using Wi-Fi



<https://www.waveform.com/tools/bufferbloat?test-id=42c9621f-ef0d-4526-8c3a-fd7c78260c6d>

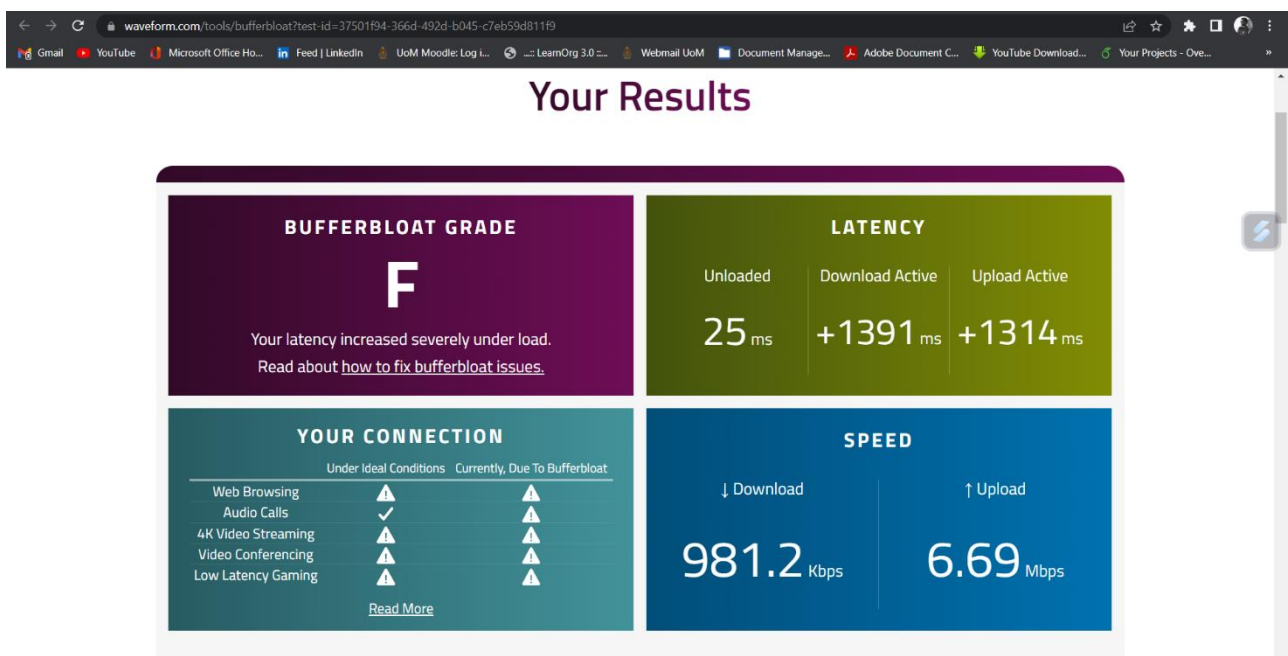
### III. At Home Using Cellular Data

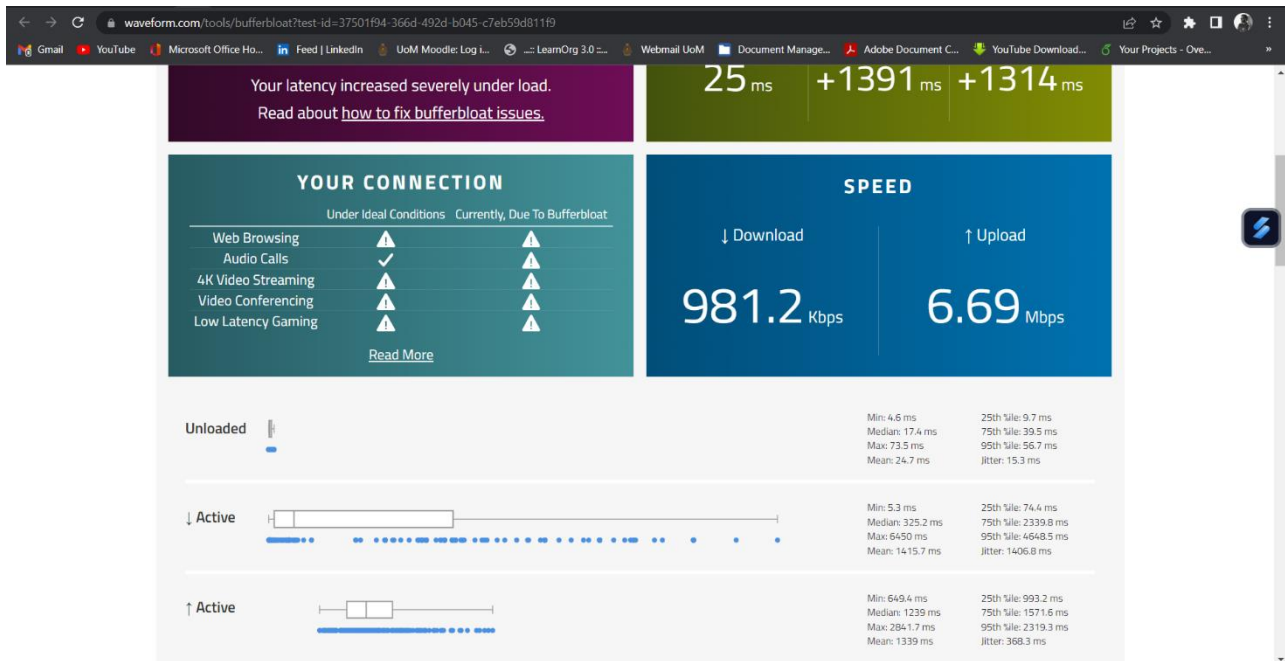




<https://www.waveform.com/tools/bufferbloat?test-id=4713ff81-a612-44d4-8048-c9e5fde67e4d>

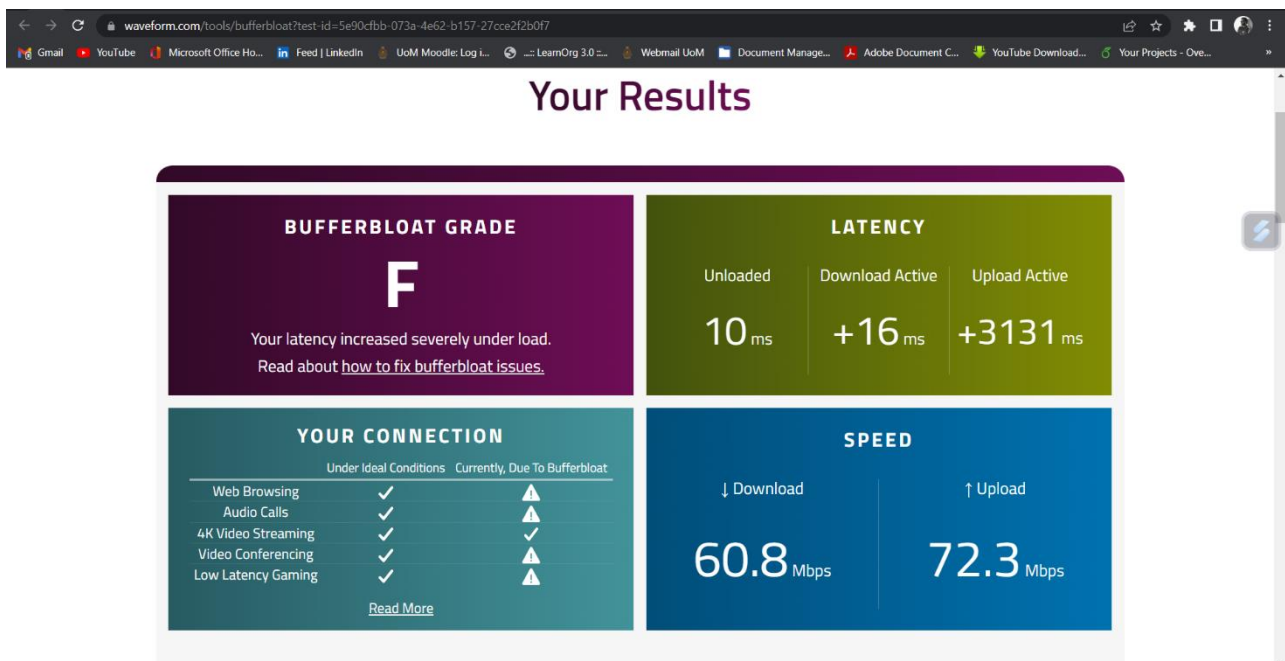
- **During Peak Traffic Time**
  - I. **At University of Moratuwa**



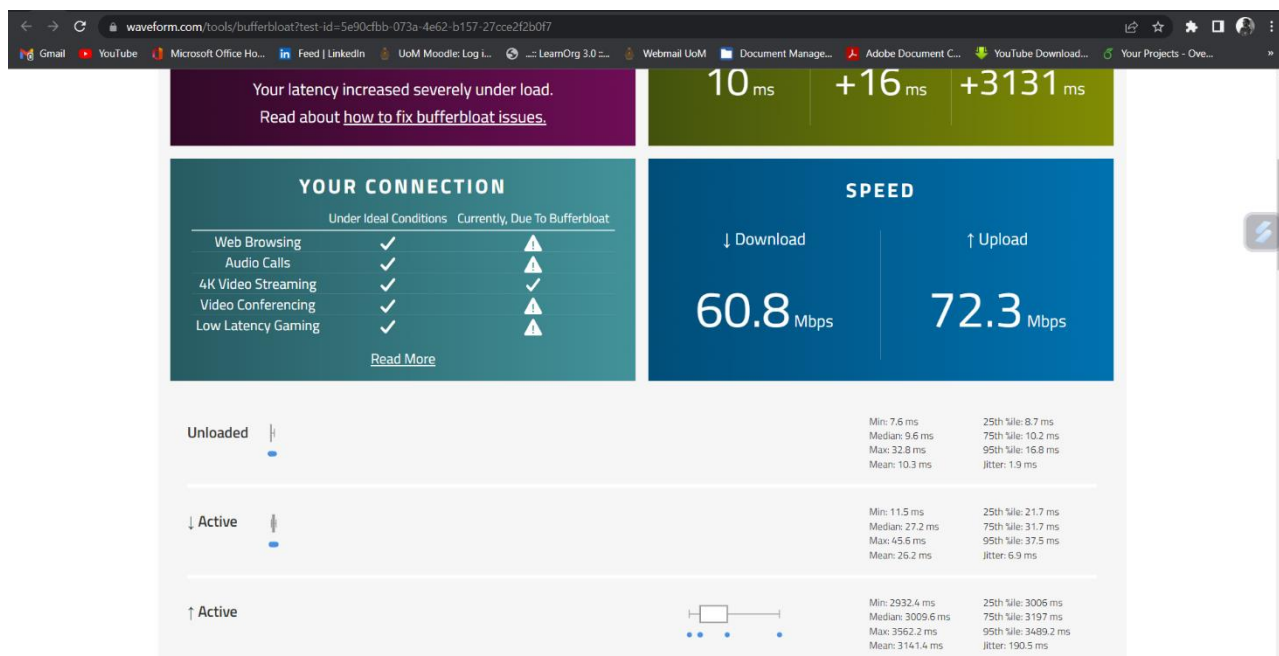


<https://www.waveform.com/tools/bufferbloat?test-id=37501f94-366d-492d-b045-c7eb59d811f9>

## II. At Home Using Wi-Fi

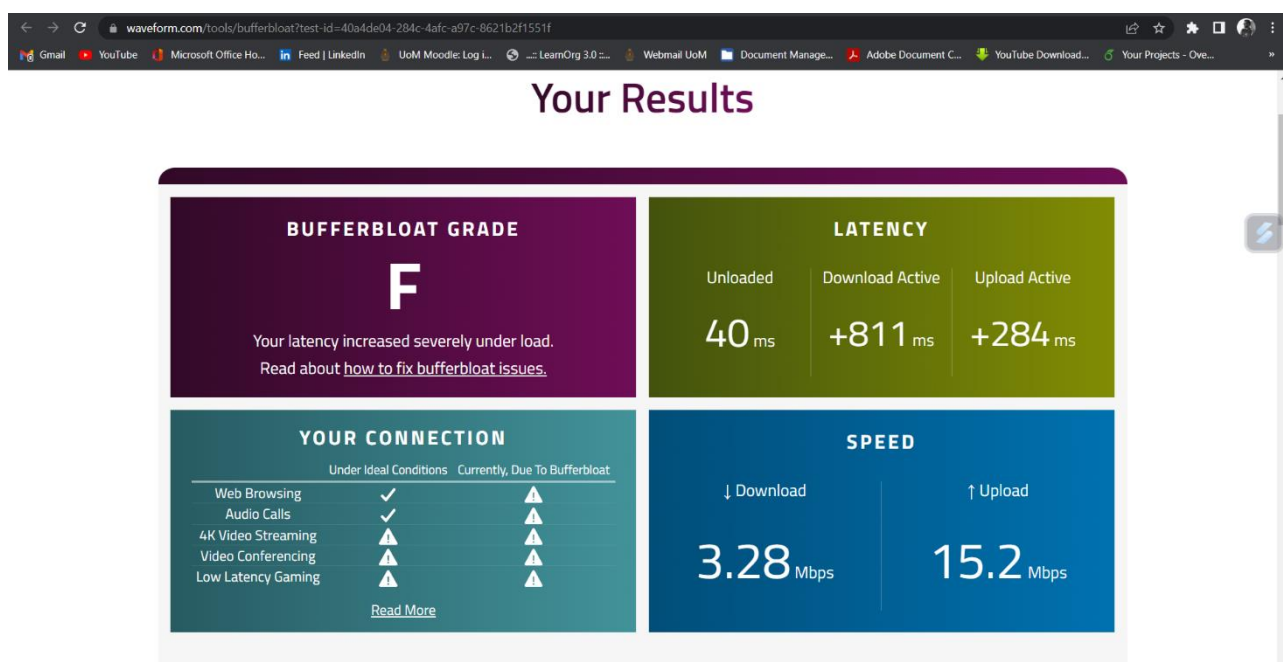


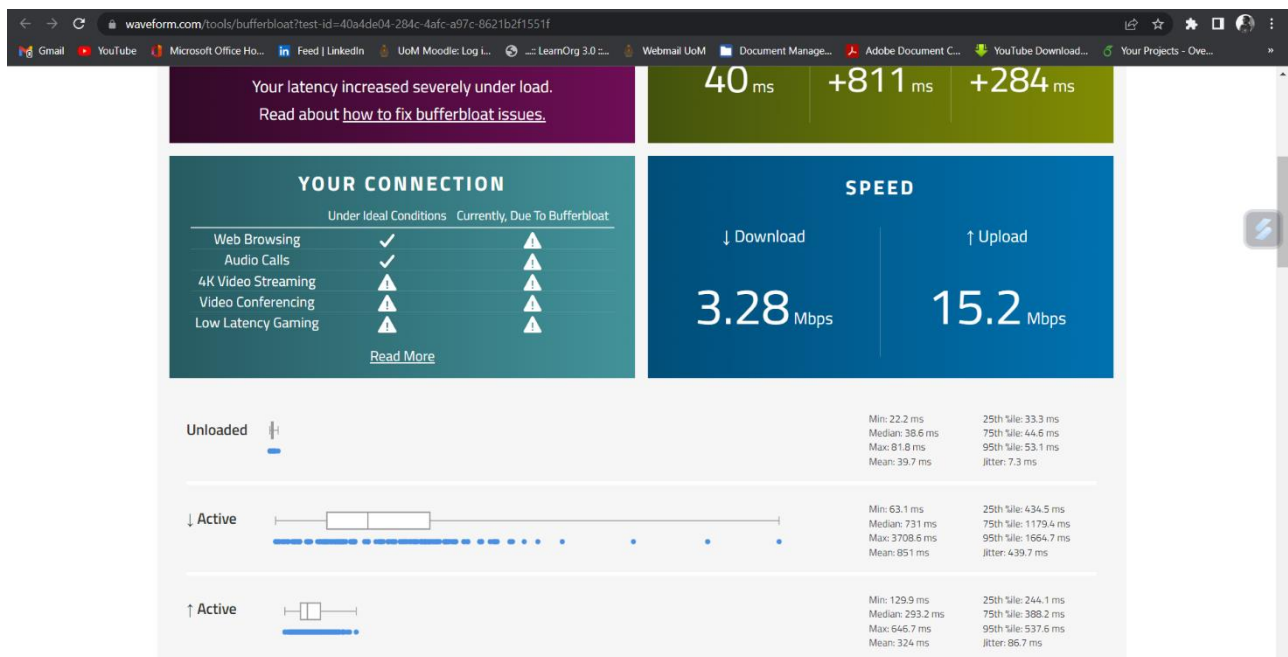




<https://www.waveform.com/tools/bufferbloat?test-id=5e90cfbb-073a-4e62-b157-27cce2f2b0f7>

### III. At Home Using Cellular Data





<https://www.waveform.com/tools/bufferbloat?test-id=40a4de04-284c-4afc-a97c-8621b2f1551f>

### Observations and Comments:

- The latency of the networks increased during the peak traffic times than the off-peak traffic times.
- According to the results obtained from the latency test, in both peak traffic and off-peak traffic times, Wi-Fi connection at home has the lowest latency and the cellular network (Mobitel in this case) has the highest latency.
- Several numbers of tests were conducted in the network at the University of Moratuwa and the results were not consistent. Even in off-peak traffic times, the latency was increasing and decreasing.
- It is recommended to improve the network at University of Moratuwa specially in crowded places such as Sentra Court, Library for a better network performance and reliability.