# Sheet 3

## 1. Data throughput on a single computer

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| **TCP** |  |  |  |
| **Connections** | **Transfer** | **Bitrate** | **Lost packages** |
| 1 | 171 GBytes | 147 Gbits/sec (sender)  146 Gbits/sec (receiver) | 4 retransmitted |
| 10 | 74.0 GBytes (sender)  73.9 GBytes (receiver) | 63.6 Gbits/sec (sender)  63.2 Gbits/sec (receiver) | 3 retransmitted |
| 100 | 50.6 GBytes (sender)  50.2 GBytes (receiver) | 43.5 Gbits/sec (sender)  43.1 Gbits/sec (receiver) | 12726 retransmitted |

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| **UDP** |  |  |  |
| **Connections** | **Transfer** | **Bitrate** | **Lost packages** |
| 1 | 1.25 MBytes | 1.05 Mbits/sec (sender)  1.04 Mbits/sec (receiver) | 0 |
| 10 | 12.5 MBytes | 10.5 Mbits/sec (sender)  10.4 Mbits/sec (receiver) | 0 |
| 100 | 125 MBytes | 105 Mbits/sec | 0 |

We can see some clear differences between UDP and TCP. Most notably, UDP does not lose any packages whereas TCP has to retransmit some, especially for 100 clients. Looking at how much data has been transferred we can also see that the sender has sent more data than the receiver. Since TCP resends packages which don’t get an ACK in a specified amount of time there should be no packages truly lost, only some resent. Maybe the packages would have arrived anyway, just to late, due to this reason we can’t conclusively say if the packages have been lost or have been simply late.

Furthermore, TCP sends a lot more data than UDP. The transfer of TCP consists of GBytes while UDP only sends some MBytes. UDP will simply increase the data sent by 10 when increasing the clients by 10, TCP on the other hand starts to send less data. The same can be seen in the Bitrate, UDP sends faster the more clients there are, TCP will get slower.

## 2. Data throughput between two computers connected via WiFi

a) & b)

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| **TCP** |  |  |  |
| **Connections** | **Transfer** | **Bitrate** | **Lost packages** |
| 1 | 153 MBytes (sender)  152 MBytes (receiver) | 128 Mbits/sec (sender)  126 Mbits/sec (receiver) | 2 retransmitted |
| 10 | 174 MBytes (sender)  167 MBytes (receiver) | 146 Mbits/sec (sender)  137 Mbits/sec (receiver) | 146 retransmitted |
| 100 | 191 MBytes (sender)  170 MBytes (receiver) | 160 Mbits/sec (sender)  137 Mbits/sec (receiver) | 1053 retransmitted |

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| **UDP** |  |  |  |
| **Connections** | **Transfer** | **Bitrate** | **Lost packages** |
| 1 | 1.25 MBytes | 1.05 Mbits/sec | 0 |
| 10 | 12.5 MBytes | 10.5 Mbits/sec | 0 |
| 100 | 125 MBytes | 105 Mbits/sec | 0 |

We can see that UDP once again does not lose any packages whereas TCP does retransmit some of them. This can also be seen in the fact that the sender sends more data than the receiver while the sent data is the same for client and server in UDP.

Here, TCP has more or less always the same amount of data sent and the bitrate is also pretty constant. UDP on the other hand increases its data sent and the bitrate when you increase the number of clients.

c) TCP actually loses less packets than if we run it on a single laptop, why that is the case we’re not sure, maybe it also has to do with the OS or some other factor. TCP also sends less data, now there are MBytes being sent instead of GBytes like there were on a single computer.

UDP on the other hand behaves the same as on one computer. This makes sense since UDP doesn’t care whether or not the other side receives the packets in a certain amount of time, it just sends them and hopes for the best.

d) Running YouTube on the client:

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| **TCP** |  |  |  |
| **Connections** | **Transfer** | **Bitrate** | **Lost packages** |
| 1 | 3.69 MBytes (sender)  932 Kbytes (receiver) | 3.09 Mbits/sec (sender)  725 Kbits/sec (receiver) | 36 retransmitted |
| 10 | 15.2 MBytes (sender)  3.88 MBytes (receiver) | 12.6 Mbits/sec (sender)  3.06 Mbits/sec (receiver) | 131 retransmitted |
| 100 | 18.7 MBytes (sender)  3.18 MBytes (receiver) | 15.7 MBits/sec (sender)  2.58 Mbits/sec (receiver) | 786 retransmitted |

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| **UDP** |  |  |  |
| **Connections** | **Transfer** | **Bitrate** | **Lost packages** |
| 1 | 1.25 MBytes | 1.05 Mbits/sec (sender)  1.03 Mbits/sec (receiver) | 0 |
| 10 | 12.5 MBytes | 10.5 Mbits/sec (sender)  10.3 Mbits/sec (receiver) | 0 |
| 100 | 125 MBytes (sender)  17.9 MBytes (receiver) | 105 Mbits/sec (sender)  12.0 Mbits/sec (receiver) | 72% lost (34002/46943) |

First of all, we can clearly see that the sender has more trouble getting through to the client. In TCP the sender sends way more data than the receiver and the receiver also has a noticeably slower bitrate.

UDP behaves the same as before, except when we have 100 clients. Now the sender sends a lot more data than the receiver and has a slower bitrate. This is due to the fact that we now lose almost ¾ of all packages.

## 3. Data throughput using the Internet

a) We used speedtest.uztelecom.uz -p 5200

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| **TCP** |  |  |  |
| **Connections** | **Transfer** | **Bitrate** | **Lost packages** |
| 1 | 168 MBytes (sender)  167 MBytes (receiver) | 141 Mbits/sec (sender)  140 Mbits/receiver) | 0 retransmitted |
| 10 | 259 MBytes (sender)  250 MBytes (receiver) | 218 Mbits/sec (sender)  210 Mbits/sec (receiver) | 44 retransmitted |
| 100 | 400 MBytes (sender)  358 MBytes (receiver) | 336 Mbit/sec (sender)  300 Mbits/sec (receiver) | 281 retransmitted |

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| **UDP** |  |  |  |
| **Connections** | **Transfer** | **Bitrate** | **Lost packages** |
| 1 | 1.25 MBytes | 1.05 Mbits/sec | 0 |
| 10 | 12.5 MBytes | 10.5 Mbits/sec | 0 |
| 100 | 125 MBytes | 105 Mbits/sec | 43 |

For TCP we see that we don’t lose that many packets. The data and the bitrate both slightly increase when adding more clients. UDP behaves as always, but for 100 we have some packages being lost but not as much as when we have YouTube running in the background.