COMP 3331/COMP 9331 2021 T2 Week 1 Lecture 2

# Announcement and updates

* Videos for the Week 1 lectures are available on the YouTube and Echo360 playlists. Links are on the [Lectures](https://webcms3.cse.unsw.edu.au/COMP3331/21T2/resources/60188)Page.
* Week 1 slides are updated with answers to the Zeetings quizzes.
* We will use Ed Discussions for the course forum. You can join it through the following link: <https://edstem.org/join/8egWkk>. All questions and discussions pertaining to the course should be posted on Ed.
* A [self-study Lab](https://webcms3.cse.unsw.edu.au/COMP3331/21T2/resources/60271)that introduces you to the various networking tools to be used in the course is available. This lab is NOT marked.
* Labs begin in Week 2. The links to the Zoom/Teams meetings and recordings are posted on the [Labs](https://webcms3.cse.unsw.edu.au/COMP3331/21T2/resources/60133)page.
* Practice questions are available on the [Homework Questions](https://webcms3.cse.unsw.edu.au/COMP3331/21T2/resources/60275)link. Everybody is strongly urged to attempt these questions. These are useful prep for the exams. Feel free to post answers and discussions on Ed.

# 1.3 Network Core

Continue from the first lecture, we talked about the network core, in fact, section 1.3 to 1.4 are the two most important parts of week 1’s lecture, students are strongly encouraged to try the homework questions, and read the textbook to fully understand these concepts.

At the core of networks are a mesh of interconnected routers and switches. There are two forms of switches networks.

* Circuit switching: used in legacy telephone networks.
* Packet switching: used in the internet.

We talked about why packet switching is better than circuit switching (essentially circuit switching reserves bandwidth for each link from source to destination, meaning no one else can use the reserved bandwidth). We also talked about FIVE features of packet switching, students should revisit these concepts in lecture 1.

# Example (very important)

Chart

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Figure 1 Circuit Switching vs Packet Switching.

In this example, we look at how packet switching utilise the concept of statistic multiplexing to send packets. The LHS is a graph for circuit switching, there are 3 users sending packets at different timestamps. If we want to accommodate 3 users in this link using circuit switching, it is impossible because we need to reserve the bandwidth for 3 users, and it is overloading this link. If we are using packet switching, because these three users are using the Internet at different timestamps, we will not run into this issue. 3 users share the link’s bandwidth. Statistical multiplexing relies on the assumption that not all flows burst at the same time. However, this is not always guaranteed on the Internet, we will run into issues when 3 users are sending data at the same time through this link, the below graph illustrates what we do under overload condition using packet switching.



Diagram

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Figure 2 Statistical multiplexing: pipe view

In this example here we have two senders s1 and s2, they have heavy traffic, we store some of the packets in the buffer and later when the traffic is low, we can clear out the buffer. Buffer absorbs transient overload.

Diagram

Description automatically generatedWhen the overload is persistent, we have too many packets come into the network link. We fill up the buffer quickly and the buffer is never clear up, we will eventually run into issue such as packet loss.

Figure 3 Persistent overload and packet loss

## Packet switching user number

Example: a network link has the capacity of 1 Mb/s, each user in the network transfer data at a rate of 100 kb/s when “active”. Each user is active 10% of the time.

* Circuit Switching: N = 1 Mb/ 100 kb = 10 users.
* Packet Switching: N = 35 users, probability > 10 active at same time is less than .0004

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Note: Students are NOT required to understand question at this difficulty, however, simpler version of this probability calculation will be in the exam)

# 1.4 Delay, loss, throughput in networks

Delay and loss occur when packets queue in router buffers. This occurs when the packet arrival rate to a link (temporarily) exceeds the output link capacity. There are four sources of packet delay, that form part of the overall formula for the nodal delay:

1. processing delay: used to check bit errors, it is typically less than msec, often negligible compared to the overall delay

2. queuing delay: time waiting at output link for transmission, it depends on the congestion level of router

3. transmission delay: the time used to push the packet out of the link,

* L: packet length (bits)
* R: link bandwidth (bps)

4. propagation delay: the time from the out of the link to the destination,

* D: length of physical link
* S: propagation speed in medium

The end to end (E2E) delay between a source and destination is the sum of all along the path.

Diagram

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Figure 4 End to End delay illustration

**A few important points:**

1. Propagation delay DOES NOT depend on the size of the packet
2. Transmission delay DOES NOT depend on the distance between sender and receiver
3. Packet arrival rate \* Packet length / Link bandwidth = traffic intensity
4. We never want traffic intensity to be close to 1 or equal to 1

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## Traceroute (very important, useful for lab exercise)

The program traceroute provides delay measurements from a source to a router along a path via the internet towards a destination.

For all routers, traceroute will

* Send three packets that will reach router ii on path towards destination
* Router ith will return packets to sender
* Sender times interval between transmission and reply

A picture containing text, newspaper, receipt

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Figure 5 traceroute output and explanation

A few things to notice here have been highlighted in red.

* First, the biggest jump in latency in the traceroute output means the packet has been sent across the trans-oceanic link (undersea cables).
* Second, \* means there is no response or ISP disables responses to traceroute.
* Third, notice between 10 and 11 the delay time reduces for the third packet, this is because of queuing delay, the packets are not sent at the same time. Conditions of these network are constantly changing.

*Note: Throughput is pushed to next week due to time constraint.*