National University of Singapore
School of Computing
CS5229: Advanced Computer Networks
Semester I, 2021/2022

# Lecture 1 Training
# End-to-End Argument

Release date: 14th August 2021
**Due: 19th August 2021, 23:59**

In Lecture 1, we briefly discussed the end-to-end argument in system design and mentioned that there were trade offs.

In this question, we will investigate the impact of these trade offs on practical metrics that we care about. In particular, you are to determine the flow completion time (FCT, time between the first packet sent from the server to the last packet received at the receiver) and round-trip times (RTT) for different network scenarios.

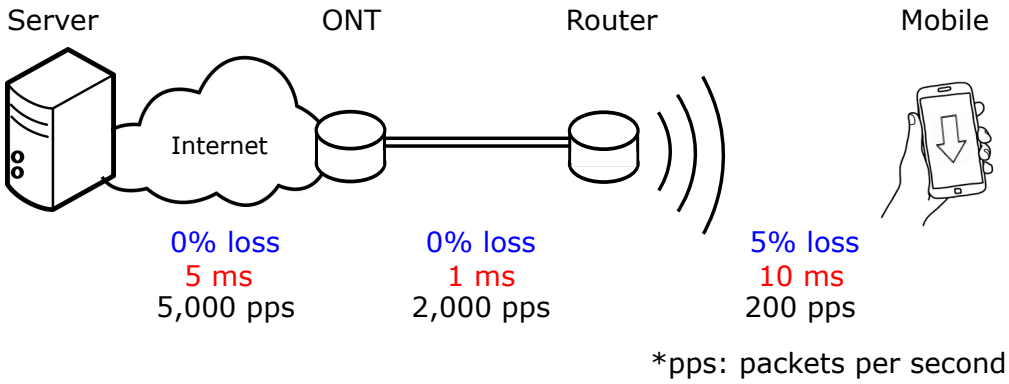


Figure 1: Simple wireless network.

Consider the network in Figure 1. Suppose the mobile end host wants to download a file consisting of 1,000 packets from the server. Each wired/wireless link in this topology has some loss rate, one-way delay, and bandwidth (in packets per second) associated with it (specified in Figure 1).

For simplicity, you can assume that there are no other competing flows in the network and that both retransmitted packets or acknowledgement packets will suffer no loss. All nodes in the network use the NACK-like retransmission policy described in Figure 2.

Basically, the packets will contain a sequence number and the receiver assumes that there is no reordering, so if it detects a skipped sequence number, it will immediately inform the sender of this missing packet via a NACK. The sender will retransmit the missing packet once it receives the NACK.

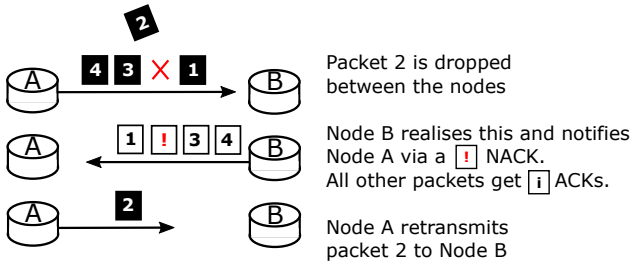


Figure 2: Retransmission policy

Given this information, answer the following questions on Coursemology:

1. What is the RTT and FCT if the loss rate at the wireless link is zero?
2. What is the expected ($E(x)$) RTT and FCT for downloading the 1,000 packet file when the loss rate at the wireless link 5%, for each of the following scenarios:
   (a) **Only** end-to-end retransmission are allowed
   (b) Link re-transmissions are allowed in the wireless link between the Router and the Mobile

You are not expected to do any complex modelling or mathematical computations to derive the above answers. In networking, we often do back-of-the-envelope calculations allow us to check that our experiments are yielding results that are within expectation.