Week 2. Tutorial Problem Solutions

Problem 6

a) $d_{prop} = m / s$ seconds.
b) $d_{trans} = L / R$ seconds.
c) $d_{end-to-end} = (m / s + L / R)$ seconds.
d) The bit is just leaving Host A.
e) The first bit is in the link and has not reached Host B.
f) The first bit has reached Host B.
g) We want $\boldsymbol{m = \frac{L}{R} s = \frac{1500\times 8}{10\times 10^6}(2.5 \times 10^8) = 3 \times 10^5 = 300}$ km.

Problem 10

Assuming the link rate between router A and router B is also 4Mbps.
The first bit sent by the host with the lowest propagation delay reaches Router A after 2ms while the last bit of the packet arrives after $2 \times 10^{-3} + 1500 \times 8 / (4 \times 10^6)$ s = 5ms, and the last bit leaves router A after $2 \times 10^{-3} + 2 \times 1500 \times 8 / (4 \times 10^6)$ s = 8ms.
The first bit sent by the host with the highest propagation delay reaches Router A after 6ms. Router A fully receives the second packet after $6 \times 10^{-3} + 1500 \times 8 / (4 \times 10^6)$ s = 9ms. At that time the first packet sent by the other host has already left the router, so no queuing delay occurs.

Problem 11

Assuming the link rate between router A and router B is R
Assume $d_1 < d_2$. No buffering occurs when $d_2 + L / R_2 > d_1 + L / R_1 + L / R$.

Problem 12

[Note: this is a case of "cut through routing", which wasn't covered in lecture. As a result, this problem can be treated as optional – not tested.]
It takes h/R time for the router to start transmitting and L/R time for the whole packet to arrive to the server, thus the end-to-end latency is $(h + L)/R$. In the scenario of N routers, it takes $(N \times h)/R$ time for the last router to start transmitting and L/R time for the whole packet to arrive to the server, so the end-to-end latency is $(N \times h + L)/R$. Note how the end-to-end delay here is much lower than the value given by Equation (1.2) if the header is small compared to the packet size.