

Problems from Link Utilization of protocols

The link utilization $U = 1/(1+2a)$

$$U = L/(L+BR), L \rightarrow \text{packet Length}, B \rightarrow \text{Bandwidth}, R \rightarrow \text{RTT}$$

a = Propagation time / transmission time

Q. Assume that, in a Stop-and-Wait system, the bandwidth of the line is 1 Mbps, and 1 bit takes 20 milliseconds to make a round trip. If the system data packets are 1,000 bits in length, what is the utilization percentage of the link?

Solution:

Propagation delay = 10 ms = $10/10^3$ sec

Transmission delay = $(10^3)/(10^6)$ sec

Utilization = $1/(1+2*((10/10^3)/(10^3/10^6))) \approx 5$ percent.

Q. The distance from earth to a distant planet is approximately 9×10^{10} m. What is the channel utilization if a stop-and-wait protocol is used for frame transmission on a 64 Mbps point-to-point link? Assume that the frame size is 32 KB and the speed of light is 3×10^8 m/s.

Solution:

Propagation delay = $(9 \times 10^{10} \text{ m}) / (3 \times 10^8 \text{ m/s}) = 300$ s

Utilization = $1/(1+2*(300/(32 \times 10^3 \times 8)) / (64 \times 10^6)) \approx 1.5 \times 10^{-5}$

Q. In the previous problem, suppose a sliding window protocol is used instead. For what sender window size will the link utilization be 100%? You may ignore the protocol processing times at the sender and the receiver.

Solution

we can send 1.5×10^5 packets in 1 RTT

So window size should be 150000

Q. Consider the use of 10 K-bit size frames on a 10 Mbps satellite channel with 270 ms delay. What is the link utilization for stop-and-wait ARQ technique assuming $P = 10^{-3}$?

Solution:

Link utilization = $(1-P) / (1+2a)$

Where $a = (\text{Propagation Time}) / (\text{Transmission Time})$

Propagation time = 270 msec

Transmission time = $(\text{frame length}) / (\text{data rate})$

= $(10 \text{ K-bit}) / (10 \text{ Mbps})$

= 1 msec

Hence, $a = 270/1 = 270$

Link utilization = $0.999/(1+2*270) \approx 0.0018 = 0.18\%$

Q. Consider the use of 10 K-bit size frames on a 10 Mbps satellite channel with 270 ms delay. What is the link utilization for go-back-N ARQ with window size of 7 assuming $P = 10^{-3}$?

Solution :

Channel utilization for go-back-N

= $N(1 - P) / (1 + 2a)(1-P+NP)$

P = probability of single frame error $\approx 10^{-3}$

Channel utilization $\approx 0.01285 = 1.285\%$

Q. In the previous problem, suppose a selective Repeat protocol is used instead. Then calculate what will be the link utilization.

Solution :

Channel utilization for Selective Repeat

$$= N(1 - P) / (1 + 2a)$$

Here window size will be 4 i.e. N will be 4 as the no. of bits needed for sequence number is 3.

Then apply the formula.