Open system Interconnection (OSI)

DataLink Layer

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Problems on Stop and Wait Protocol

Q0 If the bandwidth of the line is 1.5 Mbps, RTT is 45 msec and packet size is 1 KB, then find the link utilization in stop and wait.

1. **Solution** Given-**Bandwidth = 1.5 Mbps**, **RTT = 45 msec**, **Packet size = 1 KB**
2. **Calculating Transmission Delay**
   $Transmission\ delay(T_t) = \frac{Packet\ size}{Bandwidth} = \frac{1KB}{1.5Mbps}$
   $= \frac{(2^{10}x8bits)}{(1.5x106bits\ per\ sec)} = 5.461msec$
3. **Calculating Propagation Delay**
   $Propagation\ delay(T_p) = \frac{Round\ Trip\ Time}{2} = \frac{45msec}{2} = 22.5msec$
4. **Calculating Value Of a**
   $a = \frac{T_p}{T_t} = \frac{22.5msec}{5.461msec} = 4.12$
5. **Calculating Link Utilization**
   $Link\ Utilization\ or\ Efficiency\ (\eta) = \frac{1}{1+2a}$

Problems on Stop and Wait Protocol

Q1 A channel has a bit rate of 4 Kbps and one way propagation delay of 20 msec. The channel uses stop and wait protocol. The transmission time of the acknowledgment frame is negligible. To get a channel efficiency of at least 50%, the minimum frame size should be

1. **Solution** Given- **Bandwidth = 4 Kbps, Propagation delay (Tp) = 20 msec, Efficiency >= 50%**
   Let the required frame size = L bits.
2. **Calculating Transmission Delay**
   $Transmission\ delay(T_t) = \frac{Packet\ \ size}{Bandwidth} = \frac{L\ \ bits}{4Mbps}$
3. **Calculating Value Of a**
   $a = \frac{T_p}{T_t} = \frac{20msec}{\frac{L}{4Kbps}} = \frac{20\ \ msec \times 4\ \ kbps}{L}$

Problems on Stop and Wait Protocol Cont...

- **Condition For Efficiency To Be At least 50%**
  - For efficiency to be at least 50%, we must have-
  - $\frac{1}{1+2a} >= 1/2$
  - $a <= 1/2$
  - Substituting the value of a, we get-
  - $(20\ msec \times 4\ Kbps)/L\ bits <= 1/2$
  - $L\ bits >= (20\ msec \times 4\ Kbps) \times 2$
  - $L\ bits >= (20 \times 10^{-3}\ sec \times 4 \times 10^{3}\ bits\ per\ sec) \times 2$
  - $L\ bits >= 20 \times 4 bits \times 2$
  - $L >= 160$
  - From here, frame size must be at least 160 bits.

Problems on Stop and Wait Protocol

Q2 What is the throughput achievable in stop and wait protocol by a maximum packet size of 1000 bytes and network span of 10 km. Assume the speed of light in cable is 70% of the speed of light in vacuum.

- Now, Given- **L = 1000 bytes d = 10 km = 104 m v = 70% of 3 x 10^8 m/sec = 2.1 x 10^8 m/sec**
- Substituting the values in the above relation, we get-
- *Throughput* = $1000\ bytes/[2x10^4 m/(2.1x10^8 m/sec)]$ $= 1.05x10^7$ bytes per sec $= 10.5$ MBps

$$\text{Throughput} = \text{Efficiency} \times \text{Bandwidth}$$

$$\text{Throughput} = \frac{T_t}{T_t + 2 \times T_p} \times \text{Bandwidth}$$

$$\text{Throughput} = \frac{L/B}{T_t + 2 \times d/v} \times B$$

$$\text{Throughput} = \frac{L}{2 \times d/v}$$

Problems on Stop and Wait Protocol

Q3 If the packet size is 1 KB and propagation time is 15 msec, the channel capacity is 109 b/sec, then find the transmission time and utilization of sender in stop and wait protocol.

- **Solution** Given- **Packet size = 1 KB, Propagation time (T_p) = 15 msec, Channel capacity = Bandwidth (here) = 10^9 b/sec**
- **Calculating Transmission Delay-**
  $Transmission\ delay(T_t) = \frac{Packet\ size}{Bandwidth} = \frac{2^{10}\,bits}{10^9}\ bits\ per\ sec$
  $a = \frac{T_p}{T_t} = \frac{15000\mu sec}{1.024\mu sec}$
- **Calculating Sender Utilization-**
  $Sender\ Utilization\ or\ Efficiency(\eta) = \frac{1}{1+2a} = \frac{1}{(1+2x1468.46)}$

Problems on Stop and Wait Protocol

Q4 Consider a MAN with average source and destination 20 Km apart and one way delay of 100 μsec. At what data rate does the round trip delay equals the transmission delay for a 1 KB packet?

- **Solution**- Given: **Distance = 20 Km Propagation delay (T_p) = 100 μsec Packet size = 1 KB**
- We need to have-
  - Round Trip Time = Transmission delay
    2 x Propagation delay = Transmission delay
- Substituting the values in the above relation, we get-
  2 x 100 μ sec = 1 KB / Bandwidth
  Bandwidth = $(2^{10}x10^6/200)$ bytes per sec

Problems on Stop and Wait Protocol

Q5 Consider two hosts X and Y connected by a single direct link of rate 10^6 bits/sec. The distance between the two hosts is 10,000 km and the propagation speed along the link is 2 x 10^8 m/sec. Host X sends a file of 50,000 bytes as one large message to host Y continuously. Let the transmission and propagation delays be p milliseconds and q milliseconds respectively.

- **Solution**- Given: **Bandwidth = 10^6 bits/sec, Distance = 10,000 km, Propagation speed = 2 x 10^8 m/sec, Packet size = 50,000 bytes**
- **Calculating Transmission Delay-**

$$Transmission\ delay\ (T_t) = \frac{Packet\ size}{Bandwidth} = \frac{(5x10^4x8\ bits)}{10^6\ bits\ per\ sec} = 400msec$$

- **Calculating Propagation Delay-**

$$Propagation\ delay\ (T_p) = \frac{Distance}{Propagation\ speed} = \frac{10^7 m}{(2x10^8 m/sec)} = 50msec$$

Problems on Stop and Wait Protocol

Q6 The values of parameters for the stop and wait ARQ protocol are as given below-

- Bit rate of the transmission channel = 1 Mbps
- Propagation delay from sender to receiver = 0.75 ms
- Time to process a frame = 0.25 ms
- Number of bytes in the information frame = 1980
- Number of bytes in the acknowledge frame = 20
- Number of overhead bytes in the information frame = 20.

Assume that there are no transmission errors. Then the transmission efficiency (in %) of the stop and wait ARQ protocol for the above parameters is . (correct to 2 decimal places)

- **Solution** Given- **Bandwidth = 1 Mbps Propagation delay (Tp) = 0.75 ms Processing time (Tprocess) = 0.25 ms Data frame size = 1980 bytes Acknowledgment frame size = 20 bytes Overhead in data frame = 20 bytes**

Problems on Stop and Wait Protocol

- **Calculating Useful Time-**
  Useful data sent = Transmission delay of useful data bytes sent
  $= \frac{Useful\ \ data\ \ bytes\ \ sent}{Bandwidth} = \frac{(1980bytes - 20bytes)}{1Mbps} = 15.680msec$
- **Calculating Total Time-**
  Total time = Transmission delay of data frame + Propagation delay of data frame + Processing delay of data frame + Transmission delay of acknowledgment + Propagation delay of acknowledgment
  $= \frac{1980bytes}{1Mbps} + 0.75msec + 0.25msec + \frac{20bytes}{1Mbps} + 0.75msec$
- **Calculating Efficiency-**
  $Efficiency(\eta) = \frac{Usefultime}{Totaltime} = \frac{15.680msec}{17.75msec} = 88.33\%$

Problems on Stop and Wait Protocol

Q7 A sender uses the stop and wait ARQ protocol for reliable transmission of frames. Frames are of size 1000 bytes and the transmission rate at the sender is 80 Kbps. Size of an acknowledgment is 100 bytes and the transmission rate at the receiver is 8 Kbps. The one way propagation delay is 100 msec. Assuming no frame is lost, the sender throughput is — bytes/sec.

- **Solution-** Given- **Frame size = 1000 bytes Sender bandwidth = 80 Kbps Acknowledgment size = 100 bytes Receiver bandwidth = 8 Kbps Propagation delay (Tp) = 100 msec**
- **Calculating Transmission Delay Of Data Frame-**
  $Transmission\ delay(T_t) = \frac{Framesize}{Senderbandwidth} = \frac{(1000x8bits)}{(80x10^3 bits\ \ per\ \ sec)}$
- **Calculating Transmission Delay Of Acknowledgment-**
  $Transmission\ delay(T_t) = \frac{Acknowledgement\ \ size}{Receiver\ \ bandwidth} = \frac{(100x8bits)}{(8x10^3 bitspersec)}$
- **Calculating Useful Time-**
  $UsefulTime = Transmissiondelayofdataframe$

- **Calculating Total Time-**
  Total Time = Transmission delay of data frame + Propagation delay of data frame + Transmission delay of acknowledgment + Propagation delay of acknowledgment
  = 100 msec + 100 msec + 100 msec + 100 msec
- **Calculating Efficiency-** $Efficiency(\eta) = \frac{Usefultime}{Totaltime} = \frac{100msec}{400msec} = 25\%$
- **Calculating Sender Throughput-** $Sender\ throughput = Efficiency(\eta) x Sender\ bandwidth = 0.25 x 80 Kbps$

Q8 Using stop and wait protocol, sender wants to transmit 10 data packets to the receiver. Out of these 10 data packets, every 4th data packet is lost. How many packets sender will have to send in total?

- Draw a time line diagram and analyze.
  The packets will be sent as-
  1, 2, 3, 4, 4, 5, 6, 7, 7, 8, 9, 10, 10
  Total=13 frames

Thank You