Delays

- Few terminology :

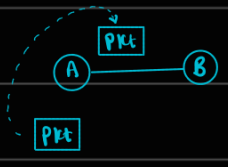
  - 1 **Bandwidth** : Rate at which a no. of bits are placed on the link in 1 second
  - 2 **Velocity** : Represent the rate, distance covered in 1 second.

Eg. A —30m— B ; Bandwidth (B) = 1bps and velocity (V) = 10m/s. Total time to travel 100m = ?

Time taken = (B x V) + Time taken by last bit = 100 + (d/V) = 100 + 3 = **103 secs**

> **NOTE** : • Data is always in powers of 2 . for eg. 1Kb = 1024 bits = 2^{10} ,
> 1Mb = $2^{10} \cdot 2^{10} = 2^{20}$ bits
>
> • Bandwidth (frequency) is always in power of 10 . for eg. 1Kbps = 10^3 bps ,
> 1mbps = $10^3 \cdot 10^3 = 10^6$ bps

- 3 **Transmission Delay (Td)** : Time taken to transfer a packet to the outgoing link

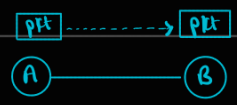


$$Td = \frac{\text{Packet size OR length of packet}}{\text{Bandwidth}} = \frac{L}{B}$$

Eg. A —— B ; Packet size = 1000 bits ; Bandwidth = 2bps

Transmission delay = Packet size / Bandwidth = 500 secs

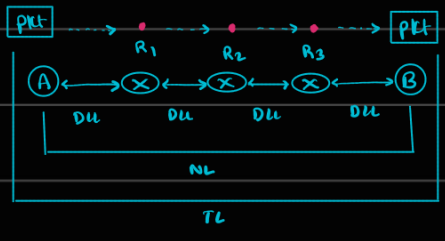
• 4 Propagative Delay (Pd) : Time taken for a packet to reach from one point to another



$$P_d = \frac{\text{Distance}}{\text{Velocity}} = \frac{d}{v}$$

Eg. A —(50m)— B ; velocity = 10 m/s. $P_d = d/v = 50/10 = 5$ secs

• 5 Queing Delay (Qd) : Time taken by a packet while waiting in queue at a router BEFORE being taken up for processing



DLL : Data link layer
NL : Network layer
TL : Transport layer

Ri : Routers. Each router has its own queing mechanism

So, there is no generalized formula for Qd.

• → Packet waiting in queue

If Qd is not given, Qd = 0 (usually negligible anyway)

• 6 Processing Delay (Pod) : Time required by a router or a destination host to receive packet from its input port, remove headers, perform error detection procedure and deliver the packet to the upper layer protocol (in case of destination host)

There is no generalized formula for Pod.

If Pod is not given, Pod = 0 (usually negligible anyway)

Eg. ① Packet size = 1KB ; Channel capacity = 10^9 b/sec. Transmission time = ?

$L = 1024 \times 8$ bits and $B = 10^9$ bits / sec.

$Td = L/B = 1024 \times 8 / 10^9 = 8.192$ µs

② (X) ——— (Y) ; Distance = 10,000 km ; Propagation Speed = 2×10^8 m/s ;

Single direct link rate = 10^6 bits / sec. X sends a file of 50,000 bytes as one large file to Y continuously. Td and Pd = ?

$$Td = \frac{L}{B} = \frac{50{,}000 \times 8}{1000000} = 400 \text{ ms} \quad \text{and} \quad Pd = \frac{d}{V} = \frac{10{,}000 \text{ km}}{2 \times 10^5 \text{ km}} = 50 \text{ ms}$$

③ (X) ——— (Y) ; Distance = m metres ; B = 512 Gbps = 512×10^9 bps ;

$L = 1KB = 1024 \times 8$ bits ; Pd along the link (v) = 2×10^9 m/s

Pd = Td. m = ?

$$Pd = Td \Rightarrow \frac{L}{B} = \frac{d}{V} \Rightarrow m = \frac{8 \times 1024 \times 2 \times 10^9}{512 \times 10^9} = 32 \text{ meter}$$

④ (Earth) ——— (Satellite) ; B = 1Mbps = 10^6 bps ; Altitude of receiver = 2100km ;

Sender Receiver Signal propagation speed (v) = 3×10^8 m/s ; L = 1000 bytes ;

Time taken (in ms) for receiver to completely receive the packet sent by the sender = ?

$$Pd = \frac{d}{V} = \frac{2100 \times 10^3}{3 \times 10^8} = 7 \text{ ms} \quad \text{and} \quad Td = \frac{L}{B} = \frac{1000 \times 8}{10^8} = 0.8 \text{ ms}$$

⇒ Total time taken = Td + Pd = 7.08 ms