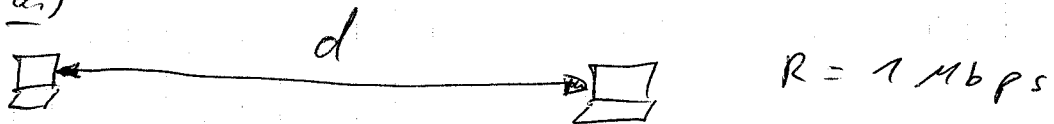


1.)

- Advantages:
 - Break a complex system into pieces \rightarrow easier to manage
 - Good reference model
 - Eases maintenance/updates
- Disadvantages:
 - Data overhead (headers etc.)
 - Optimization of individual layers is difficult in practice

\Rightarrow adds complexity to the designer (cross layer issues)

2.) a.)

Transmission Delay $\rightarrow R$, packet size $\left[\frac{L}{R} = \left(\frac{\text{bits}}{\frac{\text{bits}}{\text{sec}}} \right) \right]$
 Propagation delay $\rightarrow d$, s (speed) $\left[\frac{m}{s} \right]$

b.)

$$d_{\text{prop}} = d_{\text{trans}} \Rightarrow \frac{m}{s} = \frac{L}{R}$$

$\nwarrow 2,5 \cdot 10^8 \frac{m}{s}$
 $\nearrow 100 \text{ bits}$
 $\nearrow 28 \cdot 10^3 \text{ bps}$

$\Rightarrow m = \underline{\underline{832,86 m}}$

c.)

$m = 10.000 \text{ km}$
 $R = 1 \text{ Mbps}$
 $L = 400.000 \text{ bits}$

$s = \frac{2}{3} c$

$$t_{\text{start}} = 0$$

$$t_1 = t_{\text{first bit}} = \frac{1 \text{ bit}}{R \frac{\text{bits}}{\text{sec}}}$$

$$t_2 = t_{\text{prop}} + t_{\text{first bit}}$$

$$t_1 = 1 \cdot 10^{-6} \text{ sec}$$

$$t_2 = (1 \cdot 10^{-6} + 0,05) \text{ sec} \approx 0,05 \text{ sec}$$

$$t_{\text{prop}} = \frac{10.000 \cdot 10^3}{\frac{2}{3} \cdot 3 \cdot 10^8}$$

$$d_{\text{trans}} = \frac{40.000}{10^6} = \boxed{0,4 \text{ s}}$$

$$1 \cdot 10^{-6} + 0,05 = \frac{x}{R}$$

$$x = 5,0001 \cdot 10^4 \text{ bits}$$

5.)

a.)

~~Throughput~~ → Rate of successfully delivered data

Goodput → Rate of successfully delivered useful information

b.)

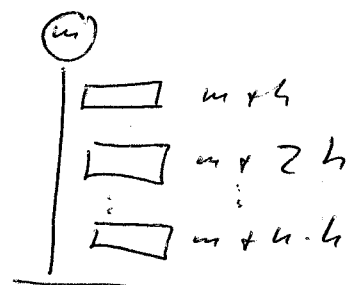
n layers

packet size m bytes

headers h bits

$$\tau \rightarrow G?$$

$$G = \frac{m}{m + n \cdot h} \cdot \tau$$



c.)

$$G = \frac{572 \text{ B}}{572 \text{ B} + 5 \cdot 20 \text{ B}} \cdot 1,5 \text{ Mbps} = 1,25 \text{ Mbps}$$