Jiankun Dong | CS 535 HW1 | (A1 Session)

1\. You set up a communication channel between two medieval castles by letting a trained raven repeatedly carry a scroll from the sending castle to the receiving castle, 160 kilometers away. The raven flies at an average speed of 40 km/h, and carries one scroll at a time. Each scroll contains 1.8 terabytes of data. Calculate the data rate of this channel when sending (i) 1.8 terabytes of data; (ii) 3.6 terabytes of data; (iii) an infinite stream of data.

bps.

1) For 1.8 tB of data, the channel only need to send once.

$$\therefore \text{Data Rate} = \frac{1.8\,tB}{\frac{160\,km}{40\,km/h}} = \frac{1.8 \times 10^6\,MB}{4 \times 3600\,\text{Sec}} = \cancel{125\,MBps} \boxed{125\,MBps}$$

2) For 3.6 tB, the raven need to fly 3x160 km total distance.

$$\therefore \text{DataRate} = \frac{1.8\,tB}{3 \times \frac{160\,km}{40\,km/h}} = \frac{125}{3}\,MBps \approx \boxed{41.67\,MBps}$$

3). For infinite stream of data, the raven need to make 2x 160 km trip per 1.8 tB on average.

$$\therefore \text{DataRate} = \frac{1.8\,tB}{2 \times \frac{160\,km}{40\,km/h}} = \frac{125}{2}\,MBps = \boxed{62.5\,MBps}$$

7. A factor in the delay of a store-and-forward packet-switching system is how long it takes to store and forward a packet through a switch. If switching time is 20 μsec, is this likely to be a major factor in the response of a client-server system where the client is in New York and the server is in California? Assume the propagation speed in copper and fiber to be 2/3 the speed of light in vacuum.

$\because C \approx 3 \times 10^8 \, m/s \qquad D_{NewYorkCal} \approx 3965km$ (to LA)

$\therefore V_{copper} \approx \frac{2}{3} C = 2 \times 10^8 m/s$

$t_{transmit} = \frac{D_{NewYorkCal}}{V_{copper}} = \frac{3.965 \times 10^6 m}{2 \times 10^8 m/s} = 19.825 \, ms.$

$\because t_{switching} = 20 \mu s = 20 \times 10^{-6} s \ll 19.825 ms$

$\therefore$ It's NOT likely to be a major factor.

11, Now that almost everyone has a home computer or mobile device connected to a computer network, instant public referendums on important pending legislation will become possible. Ultimately, existing legislatures could be eliminated, to let the will of the people be expressed directly. The positive aspects of such a direct democracy are fairly obvious; discuss some of the negative aspects.

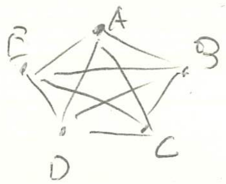
Cons: ① Internet trolls. ~~The~~ Not showing up in person means less accountability. Anyone who has sent any amount of time on Reddit knows how much trolling people do when there's no accountability.

②. Security. When it's based on online devices instead of offline methodes, it's possible for people to cheat the system ~~for~~ to get more or less votes. Or even attack the site to make some laws ~~unable~~ able to be voted on.

③ Fair of representation. Older generation might struggle with technology. Certain groups of disadvantaged people might not have access to the system.

12 Five routers are to be connected in a point-to-point subnet. Between each pair of routers, the designers may put a high-speed line, a medium-speed line, a low-speed line, or no line. If it takes 50 ms of computer time to generate and inspect each topology, how long will it take to inspect all of them?

∵ total lines amongst 5 router in a Point-to-point subnet:



$5 \times 4 / 2 = 10$ lines.

∴ total combinations $= 3^{10}$

∴ $T_{cal} = 50\text{ms} \times 3^{10} = \boxed{59049 \text{ ses}}$

28 A system has an *n*-layer protocol hierarchy. Applications generate messages of length *M* bytes. At each of the layers, an *h*-byte header is added. What fraction of the network bandwidth is filled with headers?

1)

layer n $\boxed{M}$

⋮

layer 1 $\boxed{H_1 \cdots | M}$

(H_{n-1})

$$\therefore \% = \boxed{\frac{h \cdot (n-1)}{h \cdot (n-1) + M}}$$

2) When more than 1 (N)PDU is encapsulated in (N−1)PDU:

2 (N)PDUs: $\boxed{H_i | M}$ → $\boxed{H_{i-1} | SDU_1 | SDU_2}$

layer n: $\boxed{M}$

layer n−1: $\boxed{H | M_1 | M_2}$

∴ layer 1 length $= 2^{n-1} M + (2^{n-1} - 1) h$

$$\therefore \% = \boxed{\frac{(2^{n-1} - 1) h}{2^{n-1} m + 2^{n-1} h - h}}$$

3 (N)PDUs: layer(n): M

layer(n−1): $\boxed{H\, M_1 M_2 M_3}$: $h + 3^1 M$

layer (n−2): $4h + 3^2 M$

∴ layer 1: $3^{n-1} M + \cancel{(1+3^{n-2})h}\ \frac{3^{n-1} - 1}{2} h$.

$$\therefore \% = \frac{\frac{3^{n-1} - 1}{2} h}{3^{n-1} M + \frac{3^{n-1} - 1}{2} h} = \frac{(3^{n-1} - 1) h}{2 \cdot 3^{n-1} M + (3^{n-1} - 1) h}$$

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6 (N) PDUs:

layer(n) = M

layer(n-1): $\boxed{H\ M \cdots M_6}$: $h + 6M$

layer(n-2): $6(h+6M)+h$

$$\therefore \% = \frac{\frac{6^{n-1}-1}{5}h}{\frac{6^{n-1}-1}{5}h + 6^{n-1}M} = \boxed{\frac{(6^{n-1}-1)h}{(6^{n-1}-1)h + 5\cdot 6^{n-1}M}}$$

header length at layer 1 (total):

$$S_{h(n)} = 6S_{h(n-1)} + 1$$

$$= 6^{n-2}h + \frac{1\cdot(6^{n-2}-1)}{6-1}h$$

$$= \frac{5\cdot 6^{n-2}h + 6^{n-2}h - h}{5}$$

$$= \frac{6^{n-1}h - h}{5} = \frac{6^{n-1}-1}{5}h.$$

10 (N) PDUs:

header length for n layers at layer 1:

$$S_{h(n)} = 10\,S_{h(n-1)} + 1 = 10^{(n-2)}h + \frac{1\cdot(10^{n-2}-1)h}{10-1}$$

$$= h\left(\frac{9\cdot 10^{n-2} + 10^{n-2} - 1}{9}\right)$$

$$= \frac{10^{n-1}-1}{9}h.$$

$$\therefore \% = \frac{\frac{10^{n-1}-1}{9}h}{\frac{10^{n-1}}{9}h + 10^{n-1}M} = \frac{(10^{n-1}-1)h}{(10^{n-1}-1)h + 9(10^{n-1}M)}$$

If (N-1) ~~PDU~~ PCI is half size of (N) ~~PDU~~ PCI:

~~layer(n)~~: $\boxed{M}$ layer(n-1): $\boxed{h\ M}$ layer(n-2): $\boxed{\frac{h}{2}\,|\,h\,|\,M}$ ...

$\therefore \% = \cancel{1 / \left(M + \frac{1\cdot(2-1)}{2-1}\right)}$

$\because$ header length @ layer 1 $= \left(1 + \frac{1}{2} + \cdots + \left(\frac{1}{2}\right)^{n-2}\right)h$

$$= \left(\frac{\left(\frac{1}{2}\right)^{n-1}-1}{\frac{1}{2}-1}\right)h$$

$$= \left[2 - \left(\frac{1}{2}\right)^{n-2}\right]h$$

$$= \left(2 - \frac{1}{2^{n-2}}\right)h.$$

$$\therefore \% = \frac{\left(2-\frac{1}{2^{n-2}}\right)h}{\left(2-\frac{1}{2^{n-2}}\right)h + M}$$

(N)PDUs into a (n-1)PDU:

header length @ layer 1: $\frac{N^{n-1}-1}{N-1}h$.

$$\% = \frac{(N^{n-1}-1)h}{(N^{n-1}-1)h + (N-1)N^{n-1}u}$$

the more ~~messag~~ PDUs that gets concatenated into a (N)PDU, ~~the~~ lower the % that headers (PCI) takes in the message at layer 1.

1) An image is 3840 × 2160 pixels with 3 bytes/pixel. Assume the image is uncompressed. How long does it take to transmit it over a 56-kbps modem channel? Over a 1-Mbps cable modem? Over a 10-Mbps Ethernet? Over 100-Mbps Ethernet? Over gigabit Ethernet?

$$t_{56kbps} = \frac{3840 \times 2160 \times 3\,\text{byte}}{56\,\text{kbps}} = \frac{8 \times 2.48832 \times 10^7}{5.6 \times 10^4}\,\text{s} \approx 3,5547 \times 10^3\ \text{sec}$$

$$t_{1Mbps} = \frac{3840 \times 2160 \times 3\,\text{byte}}{1 \times 10^6\,\text{bps}} \approx 199.07\ \text{sec}$$

$$t_{10Mbps} = \frac{3840 \times 2160 \times 3\,\text{byte}}{1 \times 10^7\,\text{bps}} \approx 19.91\ \text{sec}$$

$$t_{100Mbps} = \frac{3840 \times 2160 \times 3\,\text{byte}}{1 \times 10^8\,\text{bps}} \approx 1.99\ \text{sec}$$

$$t_{gigabit} = \frac{3840 \times 2160 \times 3\,\text{byte}}{1 \times 10^9\,\text{bps}} \approx 0.2\ \text{sec}$$

41. Suppose the algorithms used to implement the operations at layer *k* is changed. How does this impact operations at layers *k* – 1 and *k* + 1?

Because ~~of~~ that layers should be self-contained and performs their functions independently, changes at layer k should not impact operations at layers k-1 or k+1, ideally

I guess ~~unless~~ If the now algorithm generates bugs, ~~the~~ the lower layer consumers might be affected accordingly.

42. Suppose there is a change in the service (set of operations) provided by layer k. How does this impact services at layers k-1 and k+1?

For sevices @ layer k-1:

they shouldn't be affected since they are performed prier to layor k

For sevices @ layer k+1:

they need to ~~ta~~ take the changes into account, since layer k performs the services for layer k+1, so ~~servic~~ we might need to update services @ layer k+1 and higher.