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1) Assorted questions:

State True/False with one-sentence explanations:

(a) Data rate is both a function of the bandwidth as well as the center frequency of the transmitted signal.

(b) Applications requiring low latency (but equal bandwidth) would benefit more from FDM than TDM.

(c) A remote space telescope transmits from 5000 km away, at a data rate of 100Kbps. The total time for packet delivery to the earth station is dominated by the transmit time and not the propagation delay.

(d) When average La/R is less than 1, packets will obviously not have to wait in a queue (where 'a' is the packet arrival rate, L is the number of bits per packet, and r is the router's service rate).

(e) A network administrator tells you that 500 users can be accommodated by statistical multiplexing, given that each user needs 1Mbps and has a 25% chance of being active. With FDM, 125 such users can be accommodated.

(a)
F data rate is irrelevant to center frequency is the bandwidth is the same

(b)
T FDM has continuous connection which serves low latency application better

(c)
F the propagation delay relies on istance which is very large here

(d)
F - Packets will need to wait if all of them come in a short period of time

(e)
T $\sum_{n=125}^{500} \binom{500}{n} * 0.25^{125} * 0.7^{n-125} \approx 0.4763$ the probability of more than 125 users are using 1Mbps is 0.4763 so it may be OK to accomadate 125 user.

2) Bandwidth, data rate, and SNR:
Shannon's ground breaking equation says that: C = B log (1 + SNR) where, C is the data rate in bits/s achievable on the communication link (also called capacity), B is the bandwidth in Hz, SNR is the ratio of received signal power to the receiver?s noise power.

(a) Now, a laptop intends to transmit to its WiFi base station located R=5m away. What data rate can a WiFi laptop achieve, when transmitting at a bandwidth of 20MHz, at a power P=10 milliWatt. Assume that received signal power (Q) = P / R^2, and that noise power at the receiver is N=0.01 milliWatt.

(b) If the laptop intends to double its data rate, how close should it move to the WiFi base station.

(c) If moving close is not an option, how much should it increase its bandwidth to double its data rate.

(a) $C = B\log\left(1+\frac{P/R^2}{N/R^2}\right)$

$C = 20 \times \log(1001)$ MHz

not sure whether units needed to be aligned or not.

(b) in this case, the distance is canceled out, the data rate would not change as it move to WIFI base station.

(a) $C = B\log\left(1+\frac{P/R^2}{N}\right)$

$C = 20 \times \log(41)$ MHZ

(b) To double data rata, we need to square (1+SNR) accordy to propery of log. So $R \approx 0.77$m

(c) Accory to Shannon's ground breaky equation, the bandwidth should increase by 20MHZ

3) Web Caching:

(a) We understand that web caching reduces access latency because the content a client is looking for is already in the cache (hence, the client does not need to fetch the content from the server). This suggests that the latency reduction is proportional to the cache hit rate. However, it turns out that the latency reduction is actually much higher. Can you explain why?

(b) If UIUC has excellent web-caching performance, do you think that Parkland college users could benefit? Note that UIUC and Parkland college do not share web caches.

(a) Because for web caching, it not only reduce the latency when obtainng web documents but also it reduce network traffic from inteernet serves and reduce the # of requesty on content provider

(b) Yes, Because caching in UIUC reduce the network traffic and # of requests of the whole network which also benefies the Parkland

4) Packet Tracing:
Run `traceroute iitkgp.ac.in` on a computer, print the output, and answer the following questions:
(a) Label every field in the rows of the output.

(b) Can you track which locations are the packet flowing through.

(c) What is the average latency to reach the US coast (i.e., before going across the Atlantic Ocean).

(d) Why are there * * * in some of the rows.

(e) Make an interesting observation by looking at the screenshot, and doing some research on your own.

(f) What is reverse DNS. Research yourself and explain in one sentence.

(a) # of hops, name and/or IP address of router which hop is going through, time it took for the hop to complete the trace route (perform each hop three times)

(b) accory to online IP address finder, it goes from UIUC Internal network, Champaign, California, India

(c) the average is around 33.67ms

(d) *** means package loss in the rows; when running traceroute, it waits for response and time is out, the screen will print out *** to show the disconnection.

(e) The length of three round trip time depends on the distance to the destination and it will get no response back finally in this case As the destination goes further, the round-trip time exceeds the limit, it will keep sending *** and we can never get IP address back.

(f) Reverse DNS is IP address to domain name mapping.