Data Networks WS 18/19

INTERNET ARCHITECTURE:

Assignment 1

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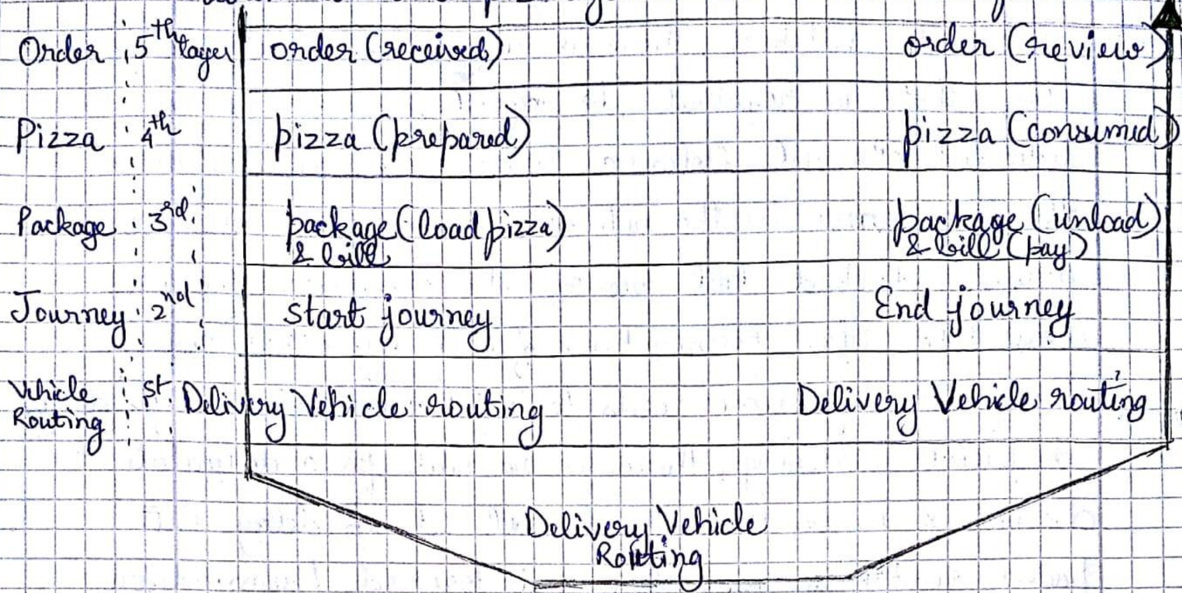
Q1: Circuit v/s Packet switching

a) In circuit switching, there is an initial call set up delay that is required to request and set up a dedicated channel between source and destination. If all channels in the network are in use, call set up maybe blocked till one of the channels becomes available upon termination of call by other users. Therefore, congestion leads to indefinite call set up delay.
In packet switching, there is no need for a dedicated channel & hence there is no call set up delay. But packet switching uses store and forward transmission due to which the entire packet must be recieved before beginning transmission onto the outbound link and this constitutes transmission delay. When an arriving packet finds the link busy with transmission of another packet, it is put on a queue which leads to queuing delay. So overload increases queuing delay. But when the queue is full, packets are dropped.

b) Link BW = 50 Mbps
1 user BW = 1 Mbps
Circuit switching requires a dedicated channel throughout the time of the call. Even if the users are only active for 10% of the call duration, a dedicated channel is required for 100% of the call duration.
∴ Maximum no of users that can be connected is $\frac{50 \text{ Mbps}}{1 \text{ Mbps}} = \underline{\underline{50 \text{ users}}}$

Q2: Layering

Layers in networks are comparable to the actions taken when a pizza joint has to deliver a pizza.



The pizza joint is required to deliver a pizza from the kitchen to the customer which is similar to packets being delivered from source to destination. But in this process a series of steps are performed by the pizza joint which are then performed in the reverse order by the customer. When these steps are viewed horizontally, we can see the process involves layers at both source & destination. So the layer at a source communicates with the corresponding layer at the destination. Also, the n^{th} layer trusts the $(n-1)^{th}$ layer to help it communicate with the n^{th} layer at the destination. ~~For example~~ Each layer provides certain services to the layer above it. For example, in 3rd layer, the pizza joint entrusts the packed pizza & the bill to the 2nd layer where a delivery boy is required to transport the pizza & ensure that the package & the bill reach the customer. So each layer provides a certain service & entrusts the layer below it to help it communicate with the corresponding layer at destination.

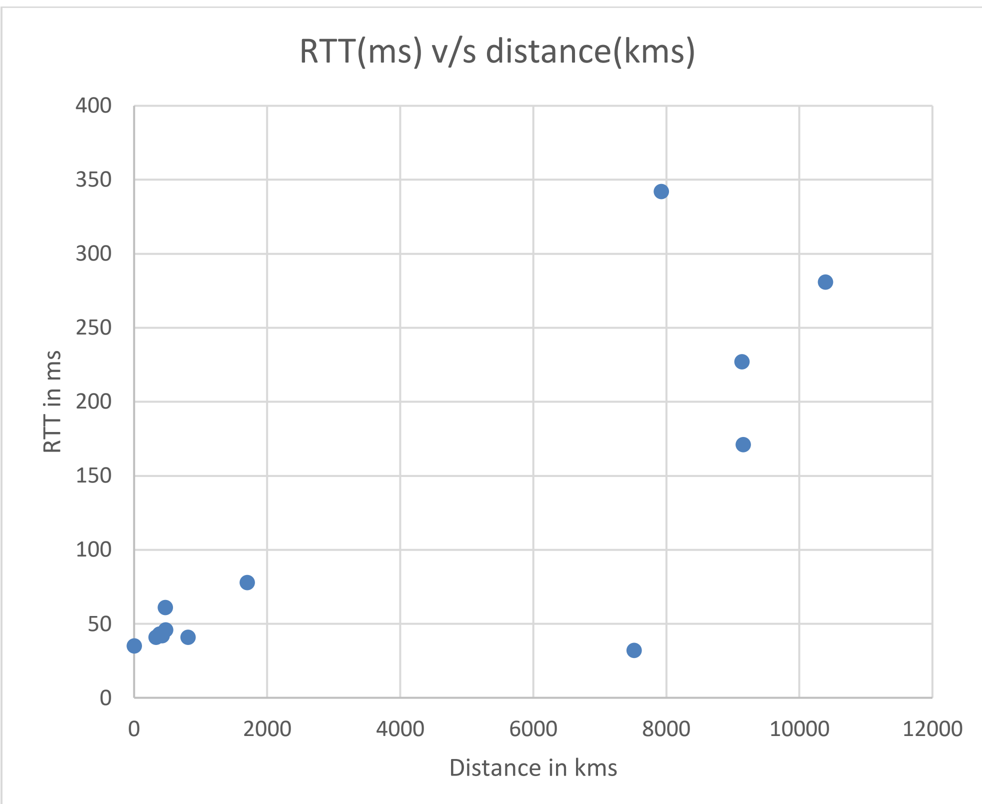
Q3) Hands on Experiments with ping

a)

Universities	Avg RTT ms	Distance kms
Uni Saarland	35ms	2.6
TU Mucnich	42ms	419
University of Muenster	43ms	383
Oxford	41ms	812
Uppsala universitet Sweden	78ms	1703
KU Leuven	41ms	330
University of Amsterdam	61ms	471
TU Delft	46ms	475
Stanford	171ms	9158
National University of Singapore	281ms	10394
Tsinghua University	342ms	7923
University of Tokyo	227ms	9135
IIM Bangalore	32ms	7514

b) Universities like IIM Bangalore, which are far from Saarbrucken still have excellent small RTT on their websites. This is because such sites use a Content Delivery Network (CDN) which is a geographically distributed network of proxy servers and their data centres. These are distributed spatially relative to end-users to provide high availability and performance. In our case, the CDN's of the websites with short RTTs ensure some of the proxy servers and data centres are located such that the distance to Saarbruecken is less than the Saarbuecken to University distance in real world.

c)



Question: 4 Sources of Packet Delay

(a) $A \rightarrow C$

$Size = 512\,bytes = 512 \times 8$ bits

$RTT = 60ms = 60 \times 10^{-3} s$

$d_{queue} = ?$

$A \leftrightarrow R \leftrightarrow C$

~~2 times oneside delay.~~

$A \longrightarrow C$ = delay is one side delay.

RTT = 2 times oneside delay

$A \leftrightarrow C$

$$60 \times 10^{-3} = 2\left(0 + d_{queue} + \left(\frac{2 \times 512 \times 8}{1 \times 10^6}\right) + \frac{201 \times 10^3}{2 \times 10^8}\right)$$

$$60 \times 10^{-3} = 2\left(0 + d_{queue} + \left(\frac{2 \times 512 \times 8}{1 \times 10^6}\right) + \left(\frac{201 \times 10^3}{2 \times 10^8}\right)\right)$$

$$30ms = d_{queue} + 8.192ms + 1.005ms$$

$$d_{queue} = 30ms - 9.197ms$$

$$\boxed{d_{queue} = 20.803\,ms}$$

(b) $C \rightarrow A$; $RTT = 18ms$; assuming empty queues.

$$18 = 2\left(2\frac{L}{R} + \frac{201 \times 10^3}{2 \times 10^8}\right)$$

$$= 2\left(2\frac{L}{1 \times 10^6} + \frac{201 \times 10^3}{2 \times 10^8}\right)$$

$$= 2\left(2L \times 10^{-6} + \frac{201 \times 10^3}{2 \times 10^8}\right)$$

$$9 = \left(2L\times10^{-6} + 1005\times10^{-6}\right)$$

$$9\times10^{6} = 2L + 1005$$

$$\Rightarrow 2L = 9\times10^{6} - 1005$$

$$2L = 8998995$$

$$L = 4499497.5$$

$$L = 4\times10^{6}\text{ bits}$$

$$L = 4.49 \text{ Mbps}$$

$$L \approx 4.5 \text{ Mbps.}$$

(c) $B \rightarrow C$

size: 1024 bytes

RTT 35ms

Assuming no queueing because we need the upper bound for the length

$$35\times10^{-3} = 2\left(0 + \overset{0}{\cancel{d_{queue}}} + \left(\frac{2\times1024\times8}{10^{6}}\right) + \left(\frac{d_2 + 200\times10^{3}\,km}{2\times10^{8}}\right)\right)$$

Considering d_2 as upper bound.

$$= 2\left(\frac{d_2}{2\times10^{8}} + \frac{200\times10^{3}}{2\times10^{8}} + 16384\times10^{-6}\right)$$

$$= 2\left(\frac{d_2}{2\times10^{8}} + 1\times10^{-3} + 16384\times10^{-6}\right)$$

$$\frac{35\times10^{-3}}{2} = \left(\frac{d_2}{2\times10^{8}} + 1000\times10^{-6} + 16384\times10^{-6}\right)$$

$$17.5\times10^{-3} - 17384\times10^{-6} = \frac{d_2}{2\times10^{8}}$$

$$17.5\times10^{-3} - 17.384\times10^{-3} = \frac{d_2}{2\times10^{8}}$$

$$1.16\times10^{-4} = \frac{d_2}{2\times10^{8}}$$

$$\boxed{d_2 \leq 23200\ km}$$

with d_2 as upper bound distance can be 23200 km.