Computer Networks

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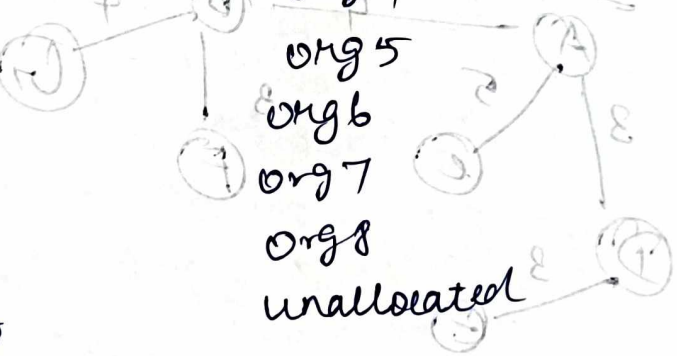
Addren splitting and routing

1) Original block : 12.44.184.0/21 → 2041 IPs
medium company : 12.44.184.0/22 → 1024 IPs.
First small company : 12.44.188.0/23
Remaining Block : 12.44.190/23
Routing: All blocks are subnets of the original /21
Routers can forward datagrams by checking longest prefix match in routing tables, directing traffic to each company based on /22 or /23

2) (a) ISP block : 16.12.64.0/20 → 4096 IPs
(b) Each org gets 256 IPs → /24 subnets.
8 organizations → 16.12.64.0/24 to 16.12.71.0/24
Remaing unallocated : 16.12.72.0/21 → 2048 IPs

(c)

destination NW	Next Hop / Interface
16.12.64.0/24	org 1
16.12.65.0/24	org 2
16.12.66.0/24	org 3
16.12.67.0/24	org 4
16.12.68.0/24	org 5
16.12.69.0/24	org 6
16.12.70.0/24	org 7
16.12.71.0/24	org 8
16.12.72.0/21	unallocated



4) (a) M bit = 1, offset = 0
This is the first fragment, there are more fragment ahead, 7, 8, 9

(b) M bit = 1, offset ≠ 0
this is a middle fragment (not the first, not the last, more fragments) 7, 8, 9.

(5) Bellman-Ford Eqn (Dxy)

$D_{xy} = \min(D_{ay} + c_{xa} + D_{by} + c_{xb} + D_{cy} + c_{xc} + D_{dy} + c_{xd})$

$= \min(5+2, 6+1, 4+3, 3+1)$

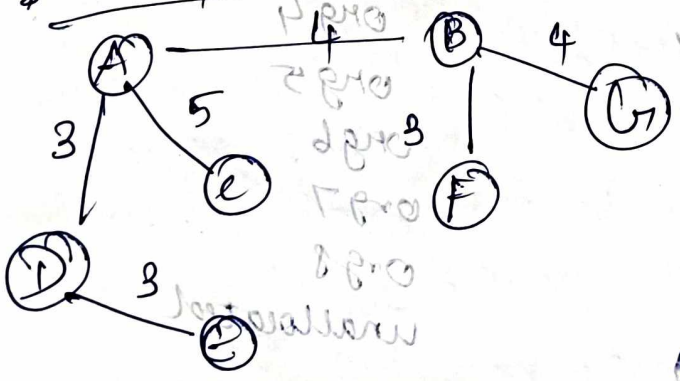
$= \min(7, 7, 7, 4)$

$D_{xy} = 4$

6)

Iteration	Tree	B	C	D	E	F	G
Init	{A}	4	~~5~~	(3)	∞	∞	∞
1	{A, D}	(4)	5	—	6	∞	∞
2	{A, D, B}	—	(5)	—	6	7	8
3	{A, D, B, C}	—	—	—	(6)	7	8
4	{A, D, B, C, E}	—	—	—	—	(7)	8
5	{A, D, B, C, E, F}	—	—	—	—	—	(8)
6	{A, D, B, C, E, F, G}	—	—	—	—	—	—

Min. Spanning Tree



Forwarding Table for node A

Destination	Next Hop
B	B
C	C
D	D
E	C
F	C
G	B

7) IPv6 colon Hex Notation

(a) 64 zeros + 32 times (01):

64 zeros → 0000:0000:0000:0000

32 times (01) → 0101:0101:0101:0101

→ Final:

0000:0000:0000:0000:0101:0101:0101:0101

(b) 64 zeros + 32 times (10)

Final:

0000:0000:0000:0000:1010:1010:1010:1010

(c) 64 two bits (01)s

Repeating (01) means 0101...

64 bits = 4 groups (16 bits per group)

5555:5555:5555:5555

(d) 32 four bit (0111)s

0111 → 7 in hex → repeat 7777...

32×4 ⇒ 128 bits →

7777:7777:7777:7777:7777:7777:7777:7777

(8) 5 bit - Sequence Number (0-31)

After 32 packets, seq. Numbers wrap around.

100 ÷ 32 = 3 full cycles + 4 remaining

So, sequence number for 100th packet = 4

(9)

(a) 1 Mbps, RTT 20ms:

→ product = 1,000,000 × 0.02

= 20,000 bits

(b) 10 Mbps, RTT 20ms:

→ product = 10,000,000 × 0.02

= 200,000 bits

(c) 1 Gbps, RTT 4ms

→ product = 1,000,000,000 × 0.004

= 4,000,000 bits.

10) Go Back N protocol

Given

Bandwidth = 100 Mbps
Distance = 10,000 km
Packet size = 100,000 bits
Speed of light in fiber = 2×10^8 m/s

propagation delay = $(10,000 \times 1000) / 2 \times 10^8$
= 0.05 seconds

Transmission delay = 100,000 bits / 100,000,000 bps
= 0.001 second

Round Trip Time = $2 \times 0.05 = 0.1$ second

Window size (m):
Bandwidth-delay product = 100,000,000 × 0.1
= 10,000,000 bits

packets in pipeline = 10,000,000 / 100,000
= 100 packets

Thus, maximum window size = m = 100

Timer = RTT = 0.1 second

11) Given

Bandwidth = 1 Gbps = 10^9 bps
Distance = 5000 km = 5×10^6 meters
propagation speed = 2×10^8 m/s
packet size = 50,000 bits

propagation delay = $\frac{5 \times 10^6}{2 \times 10^8}$ = 0.025 seconds (25 ms)

Transmission delay = $\frac{50,000}{10^9}$ = 0.00005 seconds (50 μs)

Bandwidth delay Product = $10^9 \times 0.025$
= 25,000,000 bits

Each packet = 50,000 bits

packets in the pipe = $\frac{25,000,000}{50,000}$ = 500 packets

Thus, the window size = 500 packets

For selective Repeat, the window size W must satisfy

$W \leq 2^{m-1}$

Thus $500 \leq 2^{m-1}$

$m-1 \geq \log_2 500 \approx 8.97$

$m \geq 10$

Minimum m = 10 bits for sequence number field

RTT = 2 × propagation delay

= 2 × 0.025

= 0.05 seconds

= 50 ms.

b) The IP protocol field indicates whether the packet is for TCP (protocol 6) or UDP (protocol 17), so the computer knows which transport protocol to use.

(3) Socket pairs

Client socket : (122.45.12.7, 51000)

Server socket : (200.112.45.90, 161)

(4) NO,

If the private internet uses a different protocol suite, it cannot directly use TCP/UDP - these belong specifically to the TCP/IP suite.

15) (a) if no sequence numbers consumed, next sequence number = 101
(b) if 10 sequence numbers consumed, next sequence number = 111

16) SYN, SYN+Ack and FIN consume a sequence number because they signal control information affecting the connection state. A pure Ack does not because it only acknowledges receipt without affecting the data stream.

17) The server should send a RST (Reset) segment back to the client, indicating no process is available at that port

18) client sends an Ack for (3001 + 400) = 3401
Justification: TCP Acknowledges bytes received; 400 bytes were received starting at 3001

19) Server acknowledges bytes up to (6001 + 2000) = 8001
* sending data (4001 - 5000) is independent and based on server's application logic.

20) Each DATA Chunk size: 22 (data) + 16 (header)
=> 38 bytes
Total packet size => 2 x 38
= 76 bytes.

21) Server must be always running to accept incoming client requests to any time
* client runs only when needed to initiate communication.

22) Analogy: Ordering food by phone
* First call (control connection) to place the order.
* Delivery person (data connection) bring the food
Two separate steps like FTP's control and data channels

23) Use HTTP - it's simpler, faster and designed for file downloads in modern web environments. FTP is older and more complex.

24) TELNET is useful for remote users to a device or server (eg... logging into a remote system and issuing commands directly), like a terminal session.

25) NO,
FTP requires reliable, ordered, delivery (guaranteed by TCP). UDP is unreliable, so it is not suitable for either control or data connections in FTP.