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1.

a. Since I/O bus speed is less than memory bandwidth, I/O bus is bottleneck. And each packet will pass bus twice, so the server could support:

$400\text{Mbps} / (2\text{Mbps} * 2) = 100$ switched 2Mbps T1 links.

b. throughput = $L * 1000 = 1000L$ bps

c. To make I/O bus become the limiting factor, there should be:

$1000L * 2 = 400 * 10^6$

so $L = 2 * 10^5 = 200000$ bits = 25000 bytes

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2.

a.

VC Table Entry at Switch S1

Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
1	0	3	0
1	1	3	1
3	0	0	0
3	1	0	1
2	0	3	2

VC Table Entry at Switch S2

Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
1	0	0	0
1	1	2	0
3	0	1	0
0	0	1	1
1	2	3	0

VC Table Entry at Switch S3

Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
3	0	1	0
2	0	0	0
1	0	2	0

VC Table Entry at Switch S4

Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
2	0	0	0
2	1	0	1

b.

S1:

port 0: 2

port 1: 0

port 2: 0

port 3: 3

S2:

port 0: 1

port 1: 2

port 2: 1

port 3: 1

S3:

port 0: 1

port 1: 1

port 2: 1

port 3: 0

S4:

port 0: 2

port 1: 0

port 2: 0

port 3: 0

c. sequence of VCIs from E to I is: 0 -> 0 -> 0 -> 0 -> 0

d. sequence of VCIs from B to D is: 0 -> 2 -> 0 -> 0

3.

a.

Select B1 as root bridge

Bridge	Root	Root Port	LANs
B1	B1	B1-E, B1-G	E, G
B2			
B3		B3-A, B3-D	A, D
B4		B4-G, B4-B	G , B
B5		B5-A, B5-E	A, <u>E</u>
B6			
B7			
B8		B8-E, B8-F	E , F
B9		B9-C, B9-F	C, <u>F</u>

b.

(1) Mars -> Venus: A, B, C, D, E, F, G

(2) Venus -> Mars: B, G

(3) Jupiter -> Venus: A, C, D, E, F, G

4.

a.

one-way propagation delay = $1.800/3000000 + 20 \cdot 4/500000000 = 7.6 \cdot 10^{-6} \text{ s}$

b.

150 bytes = 1200 bits

A's second send at: 7.6 us

A's finish sending at: $7.6 \text{ us} + 1200/500000000 \text{ s} = 0.0000316 \text{ s}$

A's frame is completely delivered at B at: $7.6 \text{ us} \cdot 2 + 1200/500000000 \text{ s} = 0.0000392 \text{ s}$

B's second send arrive at A at: $7.6 \text{ us} \cdot 2 + 1000/500000000 \text{ s} = 0.0000352 \text{ s} > 0.0000316 \text{ s}$

This means A's frame could be completely delivered at B at 0.0000392s.

c.

A's package will be completely delivered at B at:

$$1.800/3000000 + 20 \cdot 4/50000000 + (1 + 4) \cdot 1200 / 50000000 = 0.0001276 \text{ s}$$

5.

a.

To transmit 1000 bits packet, we need $1000/700000000 = 14\mu\text{s}$

The total time is $14\mu\text{s} + 2 \cdot 0.15\text{ms} = 0.314\text{ms}$

So the maximum effective throughput rate is $1000 / 0.000314 = 3.18 \text{ Mbps}$

b.

The token rotation time is $(0.25 + 0.15)N + 0.15 = 0.4N + 0.15 \text{ ms}$

The throughput = $1000N / (0.0004N + 0.00015) = 1000 / (0.0004 + 0.00015/N)$

When N is very large, then $0.00015/N$ could be ignored,

so the maximum effective throughput is $1000/0.0004 = 2.5 \text{ Mbps}$

c.

The throughput is

$$1000N / (0.00025N + 1000N/700000000 + 0.00015) = 1000 / (0.00026 + 0.00015/N) \text{ bps.}$$

6.

a.

A doesn't finish the transmitting.

To finish transmitting the frame, A need to transmit $128 + 1024 = 1152$ bits, however when A detects the collision, A only transmits $400 + 400 = 800$ bits < 1152 bits

b.

A finish sending jamming signal: $20\mu\text{s} \cdot 2 + 64/20000000 \text{ s} = 43.2 \mu\text{s}$

B finish sending jamming signal: $20\mu s + (128+64)/200000000 \text{ s} = 29.6 \text{ us}$

c.

A first hear idle channel again: $29.6 + 20 = 49.6 \text{ us}$

B first hear idle channel again: $43.2 + 20 = 63.2 \text{ us}$

d.

A's second signal to B: $49.6 + 20 = 69.6 \text{ us}$

B finish second preamble: $63.2 + 128/200000000 \text{ s} = 69.6 \text{ us}$

A hear next idle: $69.6\mu s + 20\mu s + 64/200000000 \text{ s} = 92.8 \text{ us}$

B hear next idle: $63.2\mu s + 20\mu s * 2 + 64/200000000 \text{ s} = 106.4 \text{ us}$

e.

B's transmission will not be successful

If B could successfully transmit the frame, the time to finish is:

$106.4\mu s + (128+1024)/200000000 \text{ s} = 164 \text{ us}$

A wait 128 bits and A's signal will arrive at B: $92.8\mu s + 20\mu s + 128/200000000 \text{ s} = 119.2\mu s < 164\mu s$

This means A's signal arrive at B before B transmit all the data.

7.

a. ip link show eth0

shows the result:

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2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP mode
DEFAULT group default qlen 1000

link/ether 04:01:2f:2b:82:01 brd ff:ff:ff:ff:ff:ff

b. arp -an

shows the result:

? (104.236.0.1) at 00:00:5e:00:01:67 [ether] on eth0
? (104.236.8.237) at 04:01:a2:8d:93:01 [ether] on eth0
? (104.236.2.36) at 04:01:92:33:e0:01 [ether] on eth0
? (104.236.13.216) at 04:01:8f:61:28:01 [ether] on eth0
? (104.236.21.63) at <incomplete> on eth0
? (104.236.50.135) at 04:01:90:a4:4e:01 [ether] on eth0
? (104.236.29.23) at 04:01:8d:bd:56:01 [ether] on eth0
? (10.132.28.110) at 04:01:ac:0a:e3:02 [ether] on eth1
? (104.236.48.221) at 04:01:91:76:3f:01 [ether] on eth0

c. netstat -s eth0
shows the result:

Ip:

13351547 total packets received
5 with invalid addresses
0 forwarded
1 with unknown protocol
0 incoming packets discarded
13351540 incoming packets delivered
13521186 requests sent out
48 outgoing packets dropped
4 dropped because of missing route

Icmp:

73089 ICMP messages received
5188 input ICMP message failed.
InCsumErrors: 28
ICMP input histogram:
destination unreachable: 70738
timeout in transit: 804
source quenches: 4
redirects: 59
echo requests: 1450
echo replies: 2
timestamp request: 4
36066 ICMP messages sent
0 ICMP messages failed
ICMP output histogram:
destination unreachable: 34612
echo replies: 1450
timestamp replies: 4

IcmpMsg:

InType0: 2
InType3: 70738

InType4: 4
InType5: 59
InType8: 1450
InType11: 804
InType13: 4
OutType0: 1450
OutType3: 34612
OutType14: 4

Tcp:

40847 active connections openings
225017 passive connection openings
8205 failed connection attempts
31945 connection resets received
6 connections established
3716467 segments received
4072370 segments send out
65311 segments retransmitted
18 bad segments received.
183297 resets sent
InCsumErrors: 18

Udp:

9578677 packets received
35579 packets to unknown port received.
2 packet receive errors
9578334 packets sent
InCsumErrors: 2

UdpLite:

TcpExt:

55073 invalid SYN cookies received
4879 resets received for embryonic SYN_RECV sockets
16 ICMP packets dropped because they were out-of-window
43476 TCP sockets finished time wait in fast timer
127 packets rejects in established connections because of timestamp
427558 delayed acks sent
32 delayed acks further delayed because of locked socket
Quick ack mode was activated 13409 times
1074 times the listen queue of a socket overflowed
1186 SYNs to LISTEN sockets dropped
46105 packets directly queued to recvmsg prequeue.
13039 bytes directly in process context from backlog
1717034 bytes directly received in process context from prequeue
732492 packet headers predicted
1810 packets header predicted and directly queued to user
804735 acknowledgments not containing data payload received

411387 predicted acknowledgments
3076 times recovered from packet loss by selective acknowledgements
Detected reordering 2 times using FACK
Detected reordering 1 times using SACK
Detected reordering 29 times using time stamp
5 congestion windows fully recovered without slow start
12 congestion windows partially recovered using Hoe heuristic
14 congestion windows recovered without slow start by DSACK
7559 congestion windows recovered without slow start after partial ack
TCPLostRetransmit: 39
591 timeouts after SACK recovery
80 timeouts in loss state
4616 fast retransmits
30 forward retransmits
220 retransmits in slow start
41571 other TCP timeouts
TCP Loss Probes: 18295
TCP Loss Probe Recovery: 8247
249 SACK retransmits failed
14024 DSACKs sent for old packets
1 DSACKs sent for out of order packets
3176 DSACKs received
8 DSACKs for out of order packets received
372 connections reset due to unexpected data
101 connections reset due to early user close
926 connections aborted due to timeout
TCPDSACKIgnoredOld: 15
TCPDSACKIgnoredNoUndo: 2261
TCP Spurious RTOs: 1320
TCPSackShifted: 5
TCPSackMerged: 7827
TCPSackShiftFallback: 14820
TCPRcvCoalesce: 78918
TCPOFOQueue: 11422
TCPOFOMerge: 1
TCPChallengeACK: 83
TCP Spurious Rtx Host Queues: 43959
TCPWantZeroWindowAdv: 290
TCPSynRetrans: 31729
TCPOrigDataSent: 2001642
IpExt:
InOctets: 1838190169
OutOctets: 6918204196
InNoECTPkts: 13349645

InECT1Pkts: 3

InECT0Pkts: 1840

InCEPkts: 59