# CSC458 Computer Networks Problem Set #1 Tutorial

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Sept 26, 2014

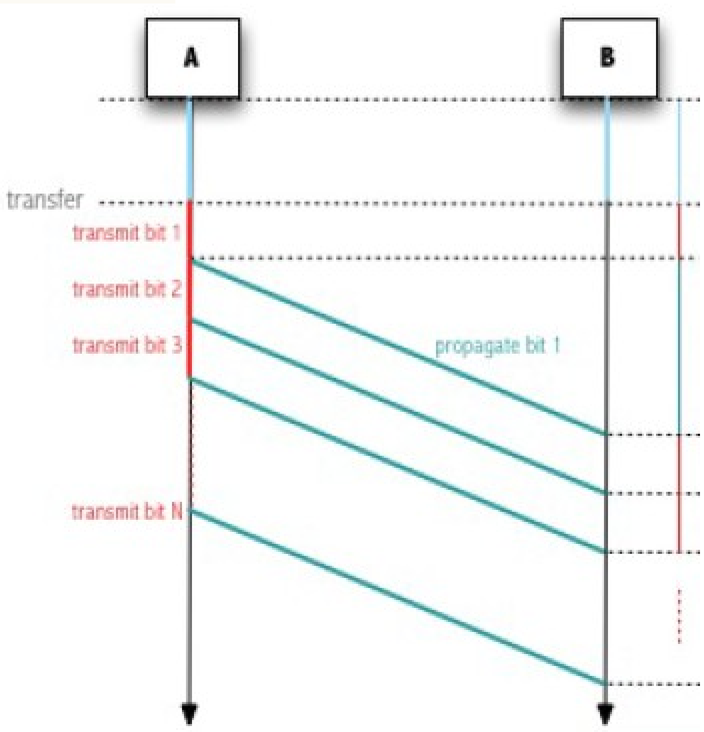
# Problem Set #1

- Due **Oct 3rd**, 2014 (next Friday)
- 10 questions from textbook (5th Edition)
  - **Ch1: 3, 12, 16, 21**
  - **Ch2: 1, 4, 12, 22**
  - **Ch3: 5, 13**
- This tutorial will go through 5 ***similar*** problems: q1.4, q1.17, q2.3, q2.13, q3.14
- Office hour (today)
  - BA 3201 for 12-1pm
  - BA3289 for 2-3pm

# Chapter 1 – 1.4

Calculate the total time required to transfer a 1.5MB file in the following cases, assuming an RTT=80ms, a packet size of 1KB, and an initial 2*RTT of “handshaking” before data is sent.

a) The bandwidth is 10 Mbps, and data packet can be sent continuously.




Continuously: transmit a whole bunch of bits.

A starts to send the first bit at 10 Mbps,
After T_{propagation} time, the bit arrives at B,
While bit#1 is propagating, bit #2 starts transmission.

$$N_{bits} = 1.5MB = 1.5 \times 2^{20} Byte \frac{8bits}{Byte} = 12 \times 2^{20} bits$$

$$T_{transm} = \frac{1}{BW \frac{bits}{sec}} = \frac{1}{BW} \frac{sec}{bit} = \frac{1}{10 \times 10^6} \frac{sec}{bit} = 0.1 \times 10^{-6} \frac{sec}{bit}$$

Total time = 2 x RTT + N x Ttransm + Tprop

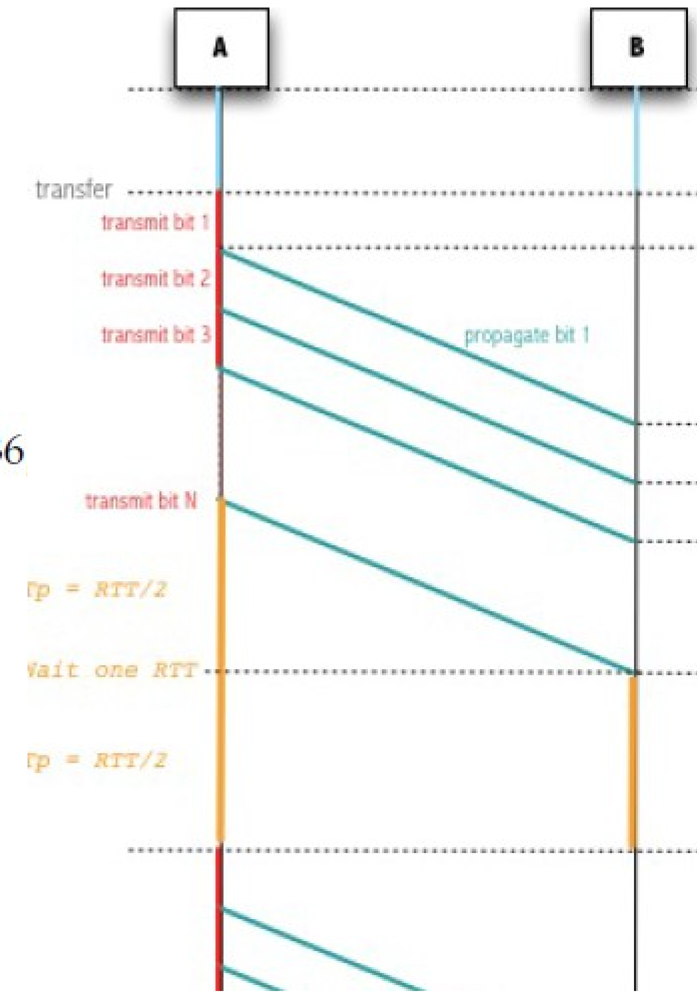
$$T_{total} = 2 \times 80 \times 10^{-3} sec + 12 \times 2^{20} bits \times 0.1 \times 10^{-6} \frac{sec}{bit} + \frac{80}{2} \times 10^{-3} sec = 1.4582 sec$$

# Chapter 1 – 1.4

a) The bandwidth is 10 Mbps, but after we finish sending each data packet we must wait one RTT before sending the next.

After receiving each packet, the reception of packet bits is only paused for RTT/2: the propagation of the last bit is concurrent with the first half of RTT pause at the transmitter A. Hence, we have

Total time = 2 x RTT + (Npack - 1) x (T1pack + RTT/2)+ T1pack




$$N_{pack} = \frac{FileSize}{PacketSize} = \frac{F_s}{P_s} = \frac{1.5MB}{1KB} = 1.5\frac{2^{20}}{2^{10}} = 1.5 \times 2^{10} packets = 1536$$

$$N_{bits-packet} = 1\frac{KB}{packet} \times \frac{2^{10}}{1K} \times \frac{8bits}{1B} = 8192\frac{bits}{packet}$$

$$T_{1pack} = N_{bits-packet} \times T_{transm} + T_{prop}$$

$$= 8192\frac{bits}{packet} \times 0.1 \times 10^{-6}\frac{sec}{bit} + \frac{80}{2} \times 10^{-3} sec_{prop} = 0.040819 sec$$

$$T_{total} = 2 \times 80 \times 10^{-3} + (1536 - 1) \times (0.040819 + 40 \times 10^{-3}) + 0.040819$$

$$= 124.2579 sec$$

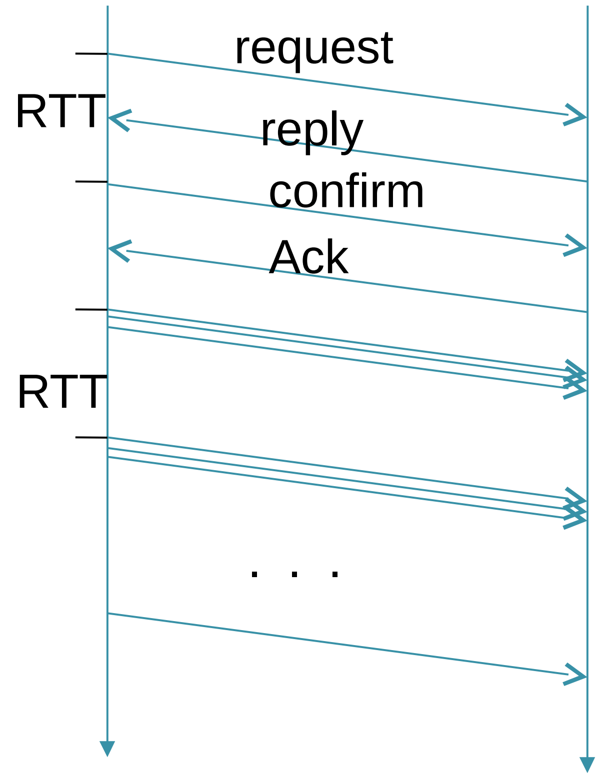
# Chapter 1 – 1.4

(c) The link allows infinitely fast transmit, but limits bandwidth such that only 20 packets can be sent per RTT.

$$N_{pack} = \frac{FileSize}{PacketSize} = \frac{F_s}{P_s} = \frac{1.5MB}{1KB} = 1.5\frac{2^{20}}{2^{10}} = 1.5 \times 2^{10} packets = 1536 packets$$

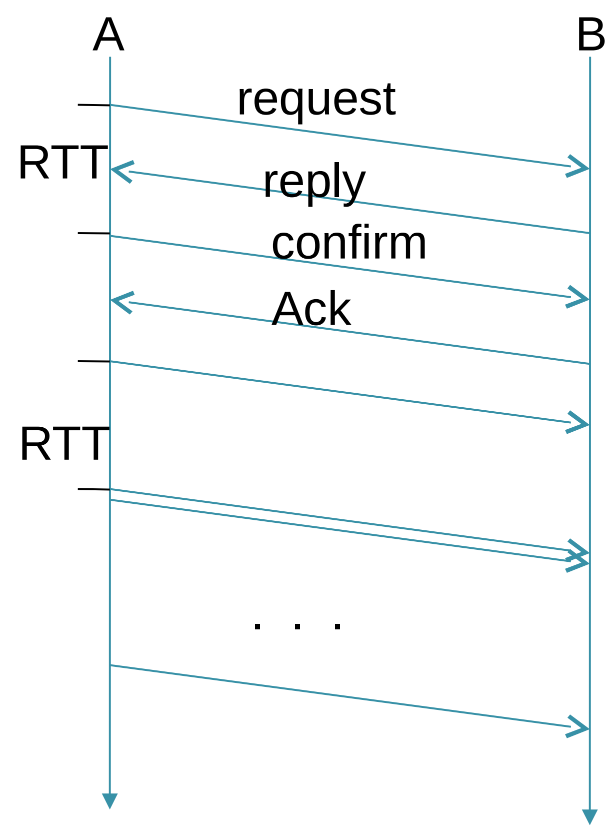
**RTT = 80 ms**
***T*t = 0 ms**
***T*p = 40 ms**

**Total time = 2xRTT + 76xRTT + *T*p**
**= 160 + 6080 + 40 ms**
**= 6.28 s**



# Chapter 1 – 1.4

(d) Zero transmit time as in (c), but during the first RTT we can send one packet, during the first RTT we can send one packet, during the second RTT we can send two packets, during the third we can send four (2^3-1) packets, etc.



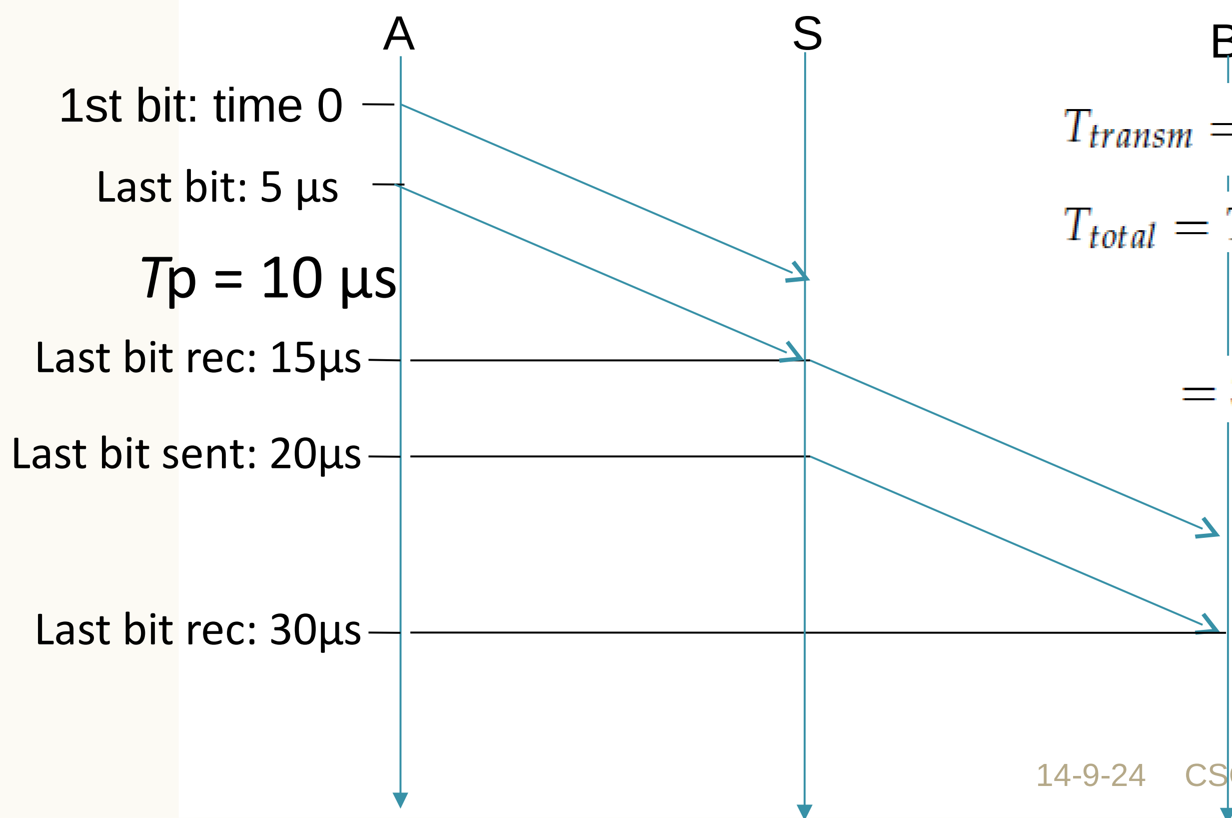

**RTT = 80 ms**
***T*t = 0 ms**
***T*p = 40 ms**
**# of packets = 1536**
**# of waits (1+2+…2n = 2n+1 -1)**

**Since 211 -1 =2047 packets,**
**At n = 10, we are able to send all 1536 packets.**

***Total time* = 2xRTT + 10xRTT + *T*p**
**= 160 + 800 + 40 ms**
**= 1 s**

# Chapter 1 – 1.17

Calculate the latency (from first bit sent to last bit received) for: (a) 1-Gbps Ethernet with a single store-and-forward switch in the path and a packet size of 5000 bits. Assume that each link introduces a propagation delay of 10 $\mu s$ and that the switch begins retransmitting immediately after it has finished receiving the packet.




$$T_{transm} = \frac{1}{BW}\frac{sec}{bit} = \frac{1}{1\times 10^9}\frac{sec}{bit} = 10^{-9}\frac{sec}{bit}$$

$$T_{total} = T_p + T_{transm}\cdot 5000$$ **A->S**

$$+ T_p + T_{transm}\cdot 5000$$ **S ->B**

$$= 30\mu sec$$

# Chapter 1 – 1.17

(b) Same as (a) but with three switches.

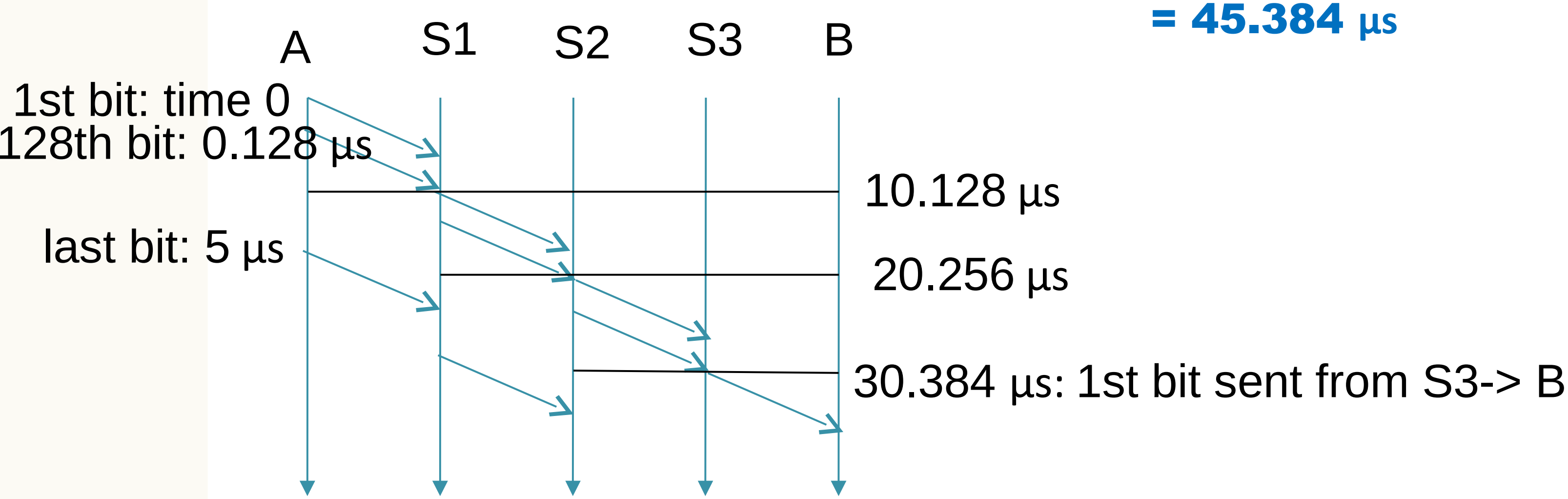
**4 links equal to 4 *T*p delay**

**4 transmissions equal to 4 *T*t delay**

**Total: 4*T*p + 4*T*t = 60 μs**

(c) Same as (b), but assume the switch implements "cut-through" switching; it is able to begin retransmitting the packet after the first 128 bits have been received.

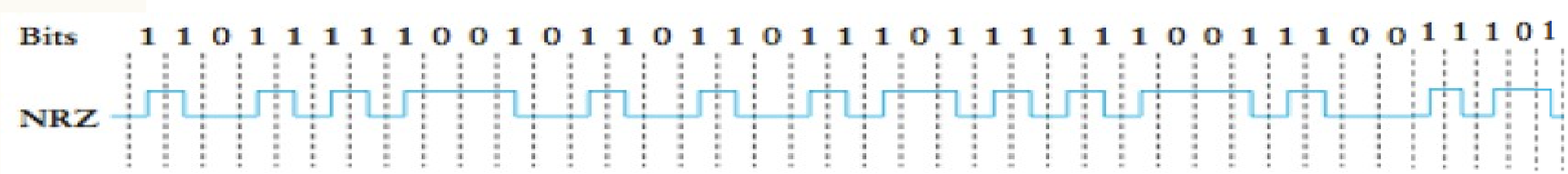
**Total time = (128*10^{-9} + 10)*3**
**+ 5000*10^{-9} +10**
**= 10.128 * 10^{-6}**
**+ 5 * 10^{-6} + 10 * 10^{-6}**
**= 45.384 μs**



# Chapter 2 – 2.3

Show the 4B/5B encoding, and the resulting NRZI signal, for the following bit sequence:
1101 1110 1010 1101 1011 1110 1110 1111

According to the 4B/5B encoding (p82 in textbook), the encoded sequence is:
11011 11100 10110 11011 10111 11100 11100 11101
NRZI:
1 – a transition from the current signal; 0 – stay at the current signal.



# Chapter 2 – 2.13

Show that two-dimensional parity provides the receiver enough information to correct any 1-bit error (assuming the receiver knows only 1 bit is bad), but not any 2-bit error.

For example, a frame contains 2 bytes of data.:

0 1 0 1 0 0 1  1
1 1 0 1 0 0 1  0

1 0 0 0 0 0 0  1
----------------------

1 bit corrupted

~~0 1 0 0 0 0 1  1~~
1 1 0 1 0 0 1  0

1 0 0 0 0 0 0  1

2 bits corrupted – unable to correct

~~0 1 0 0 0 0 1  1~~
~~1 1 0 0 0 0 1  0~~

1 0 0 0 0 0 0  1

# Chapter 3 – 3.14

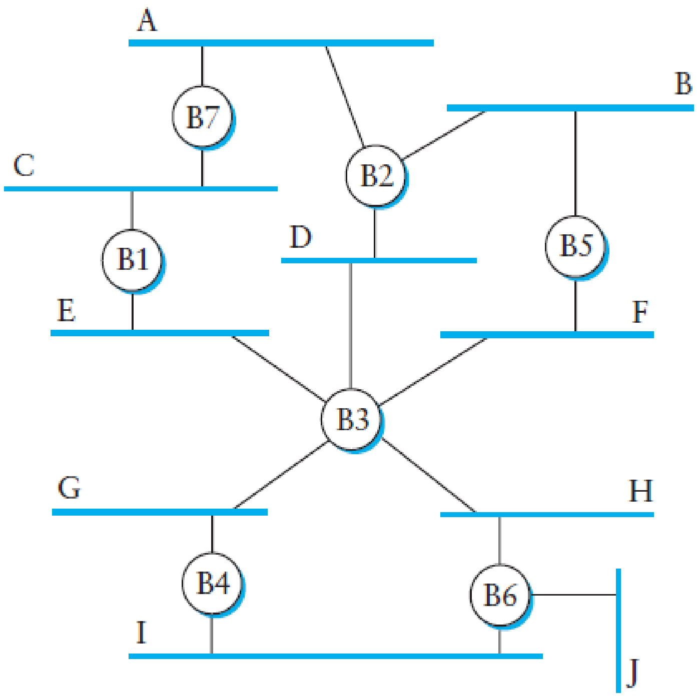
Given the extended LANs shown in the figure, assume that bridge B1 suffers catastrophic failure. Indicate which ports are not selected by the spanning tree algorithm after the recovery process and a new tree has been formed.

Spanning tree: a subgraph that covers all the vertices, but contains no cycles.

Spanning tree algorithm (p196):
The bridge of the smallest ID is chosen as root.
All ports of the root bridge are selected.

Each bridge computes the shortest path to root.
The ports on the shortest paths are selected as preferred path to the root.

Each LAN elects a designated bridge, the one being the closest to the root.



# Chapter 3 – 3.14

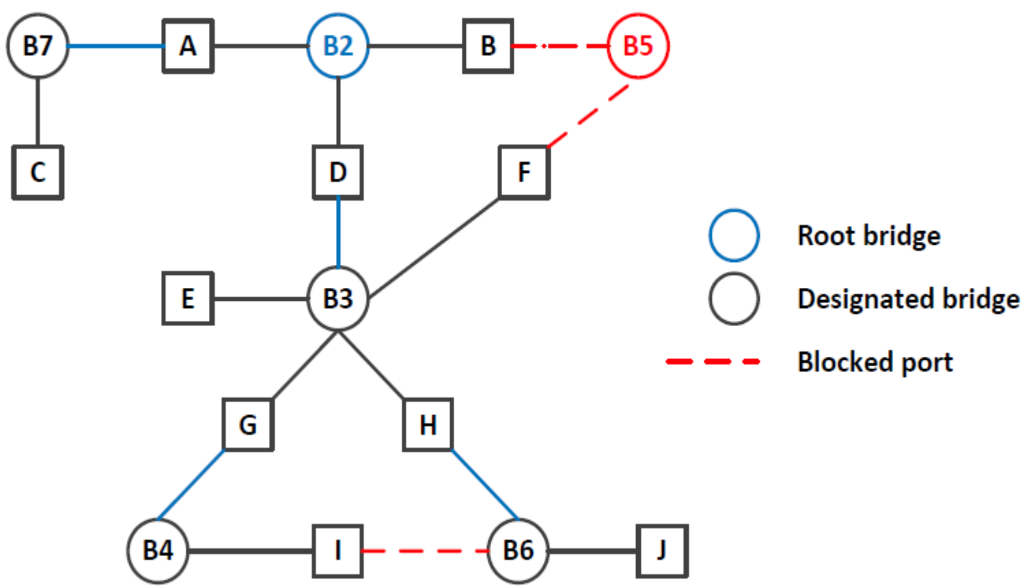
After B1 fails, B2 is selected as the root bridge.
All ports of B2 is selected – B2: A, B, D.

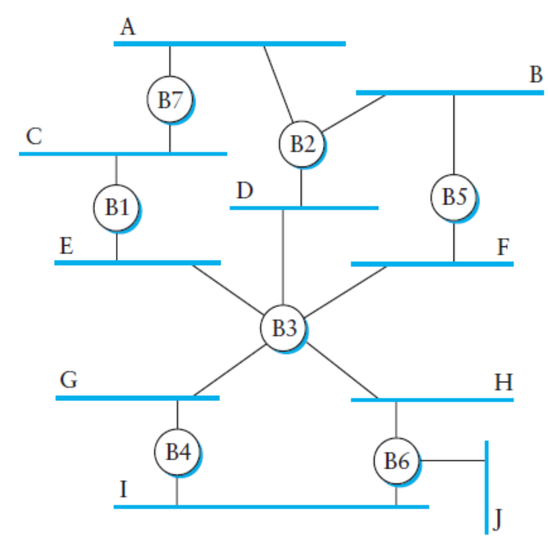
The shortest paths to B2:
B3->B2: 2
B4->B2: 4
B5->B2: 2
B6->B2: 4
B7->B2: 2

Designated bridges:

| | |
|---|---|
| LAN A: B2 | LAN F: B3 |
| LAN B: B2 | LAN G: B3 |
| LAN C: B7 | LAN H: B3 |
| LAN D: B2 | LAN I: B4 |
| LAN E: B3 | LAN J: B6 |

Blocked ports:
B5: idle
B6: I



# References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- Loukas Lazos, University of Arizona, Lecture #3 Fundamentals of Computer Networks, www2.engr.arizona.edu/~ece578/lectures/03_**Per**formance.ppt