EE3204/EE3204E CCN-I (Part 1): Semester 1, 2012-13

Tutorial 3 - Problems & Solutions

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1. Suppose that three nodes A, B and C on 10-Mbps Ethernet are stationed in that order, i.e. Node A and C are located on the left and right of node B, respectively. Nodes A and B are 500m apart whereas nodes B and C are 100m apart. Node B transmits at time t=0, a frame of length 100 Bytes destined for node C by writing node C's MAC address in the destination address field of the frame. The propagation delay is assumed to be 5μs per km. (i) At what time the first bit of the frame reaches node C? (ii) Suppose that node A starts transmitting a frame of length 100 Bytes at time t= 1 μs destined for node B. Will there be a collision? Why or Why not?

Solution

(i) The first bit reaches node C at time t = 0.5 μs

(ii) Collision occurs in this case. Though the first frame is destined for node C which is located on the right side of node B, it is propagated on both sides from B, i.e. towards node C as well as node A. The first bit of it reaches node A at time t = 2.5 μs. The frame transmission time at node B is 80 μs. Since node A starts transmitting its frame at time t= 1 μs before the completion of the frame from node B, it will collide with the frame transmitted by node B.

2. Three hosts A, B and C attempt to transmit on an Ethernet. Each host has a steady queue of frames ready to send. At an instant of time, all the three hosts attempt to send their frames simultaneously and collision occurs. We say that the three hosts enter into a backoff race. Suppose that this collision is the first, second, and third collision experienced by host A, B, and C, respectively. What is the probability that host A wins the race? Host A is said to win if it transmits its current frame successfully before any other host and also before any other collision in the network.

Solution

Host A delays for x slots where x is randomly chosen from the interval [0..1]. Host B delays for y slots where y is randomly chosen from the interval [0..3]. Host C delays for z slots where z is randomly chosen from the interval [0..7]. There exist $2\times4\times8 = 64$ possible values for the triple <x,y,z>. Host A wins under the following circumstances.

Case 1: $x = 0$; $y>0$; $z>0$; there exist $3\times7 = 21$ such triples
Case 2: $x = 1$; $y>1$; $z>1$; there exist $2\times6 = 12$ such triples

Therefore host A wins the race with probability $(21+12)/64 = 0.516$.

3. Suppose that the maximum utilization that can be achieved by a 1 km-long 10 Mbps CSMA/CD broadcast LAN is 0.8 when 4 hosts are active. What is the throughput (in Mbps) achieved when each of the 4 hosts attempts to transmit during a slot with probability 0.3? Use the simplified model for the analysis and make necessary assumptions

Solution

Number of active hosts (N) = 4.
Let the probability that a host is attempting to transmit in a slot be p.
The maximum utilization occurs when $p = 1/N = ¼ = 0.25$
The probability that only one host transmits in a slot is
$(A) = Np\,(1-p)^{N-1}$ Therefore $A = (0.75)^3 = 0.4219$
Mean number of slots in collision/idle period $n_c = 1/A - 1 = 1.3704$
Given that maximum utilization $(U_{max}) = 1/(1+2an_c) = 0.8$
This implies that $a = 0.0912$

When $p=0.3$ $A= 1.2\,(0.7)^3 = 0.4116 \Rightarrow n_c = 1.4295 \Rightarrow$
Utilization = $0.7932 \Rightarrow$ throughput = 7.932 Mbps

4. Which of the following types of connections can use full duplex (Choose all possible options)

(a) hub to hub (b) host to host (c) switch to switch (d) switch to hub (e) switch to host

Solution

(b), (c), and (e) can use full duplex connections. Full duplex must be used between two devices capable of running full duplex for the purpose of pint-to-point connections. Hubs cannot run full duplex Ethernet whereas switches and hosts can.

5. Both layer-2 switches (eg. Ethernet switch) and layer-3 switches (eg. IP routers) can be used to interconnect LANs. List down the pros and cons of these two approaches.

Solution

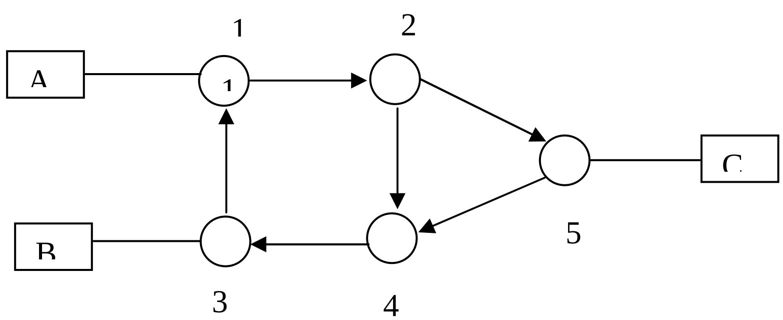
We generally use the term “switch” to refer to layer-2 switch and “router” to layer-3 switch. Switches are “plug-and-play” devices as they don’t require any intervention or configuration from network administrators and users. On the other hand routers are not plug-and-play meaning that configurations of IP addresses are needed when hosts are connected to the routers. The packet forwarding rates are higher in switches than routers as switches process frames only up to layer 2 whereas routers need to process up to layer 3 incurring more overhead and delay. Routers do more intelligent routing than switches as the latter use spanning trees for packet routing whereas routing is more flexible in routers as they can select good routes based on routing protocols and dynamic state of the network. Generally switches are preferred for interconnecting small networks whereas routers are preferred for interconnecting large networks.

6. Fast Ethernet has the same 64-byte minimum frame size as the traditional 10Mbps Ethernet, but has a higher bandwidth of 100Mbps. How is it possible to maintain the same minimum frame size?

Solution

The minimum size is needed to make sure that the sender is still transmitting in the event of collision at the farthest end of the cable. Fast Ethernet limits the cable length to 1/10 of that of Ethernet thus is able to have the same minimum frame length with bandwidth 10 times that of Ethernet.

7. Consider the ATM network shown in the following figure with three hosts A, B, and C and five switches 1, 2, 3, 4, and 5. ATM connections are routed between each of the node-pairs <A,B>, <A,C>, <B,A>, <B,C>, <C,A>, and <C,B> . Show the VCI table at each of the switches indicating the VCIs in the input and output ports. The routing is carried out in the order in which the above node-pairs are listed and VCIs are assigned starting from 1. The connections use the shortest path to their destination.



Solution

The shortest paths for the given node pairs are as follows:

A -> B : A -> 1 -> 2 -> 4 -> 3 -> B
A -> C : A -> 1 -> 2 -> 5 -> C
B -> A : B -> 3 -> 1 -> A
B -> C : B -> 3 -> 1 -> 2 -> 5 -> C
C -> A : C -> 5 -> 4 -> 3 -> 1 -> A
C -> B : C -> 5 -> 4 -> 3 -> B

NODE 1

VCI_{in}	$Port_{in}$	VCI_{out}	$Port_{out}$
1	A->1	1	1->2
2	A->1	2	1->2
1	3->1	1	1->A
2	3->1	3	1->2
3	3->1	2	1->A

NODE 2

VCI_{in}	$Port_{in}$	VCI_{out}	$Port_{out}$
1	1->2	1	2->4
2	1->2	1	2->5
3	1->2	2	2->5

NODE 3

VCI_{in}	$Port_{in}$	VCI_{out}	$Port_{out}$
1	4->3	1	3->B
1	B->3	1	3->1
2	B->3	2	3->1
2	4->3	3	3->1
3	4->3	2	3->B

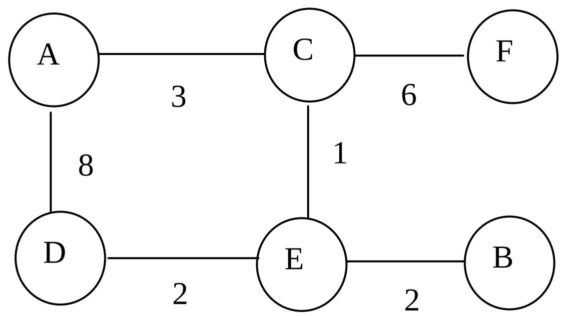
NODE 4

VCI_{in}	$Port_{in}$	VCI_{out}	$Port_{out}$
1	2->4	1	4->3
1	5->4	2	4->3
2	5->4	3	4->3

NODE 5

VCI_{in}	$Port_{in}$	VCI_{out}	$Port_{out}$
1	2->5	1	5->C
2	2->5	2	5->C
1	C->5	1	5->4
2	C->5	2	5->4

8. For the network given below, give the datagram forwarding table for nodes C and E. The links are labeled with relative costs; the tables should forward each packet through the shortest path to its destination.



Solution

NODE C

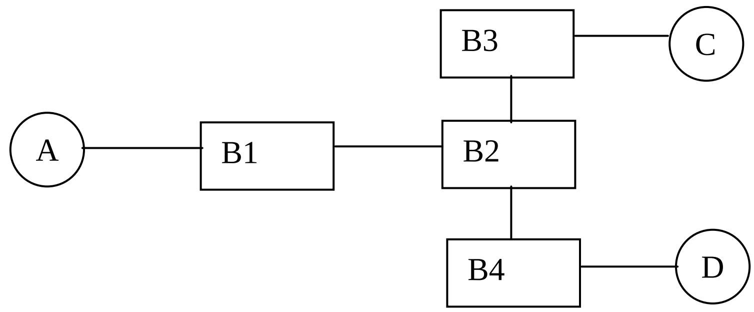
Destination	Next Hop
A	A
B	E
D	E
E	E
F	F

NODE E

Destination	Next Hop
A	C
B	B
C	C
D	D
F	C

9. Consider the arrangement of learning bridges shown below. Assuming that all are initially empty, give the forwarding tables for each of the bridges B1-B4 after the following transmissions.

(i) A sends to C, (ii) C sends to A, and (iii) D sends to C



<u>Solution</u>

(i) When A sends to C, every bridge forwards the packet through all the interfaces as none of the bridges knows where A is; all bridges learn where A is.

(ii) When C sends to A, the packet uses the path C – B3 – B2 – B1 – A as every bridge knows where A is; Bridges B3, B2, and B1 learn where C is; Bridge B4 does not learn where C is.

(iii) When D sends to C, B4 sends the packet to B2 which forwards it to B3 which in turn forwards it to C; Bridges B4, B2, and B3 learn where D is; Bridge B1 does not learn where D is.

The forwarding tables are built as follows:

Bridge B1

Host	Port
A	B1 $\rightarrow$ A
C	B1 $\rightarrow$ B2

Bridge B2

Host	Port
A	B2 $\rightarrow$ B1
C	B2 $\rightarrow$ B3
D	B2 $\rightarrow$ B4

Bridge B3

Host	Port
A	B3 $\rightarrow$ B2
C	B3 $\rightarrow$ C
D	B3 $\rightarrow$ B2

Bridge B4

Host	Port
A	B4 $\rightarrow$ B2
D	B4 $\rightarrow$ D