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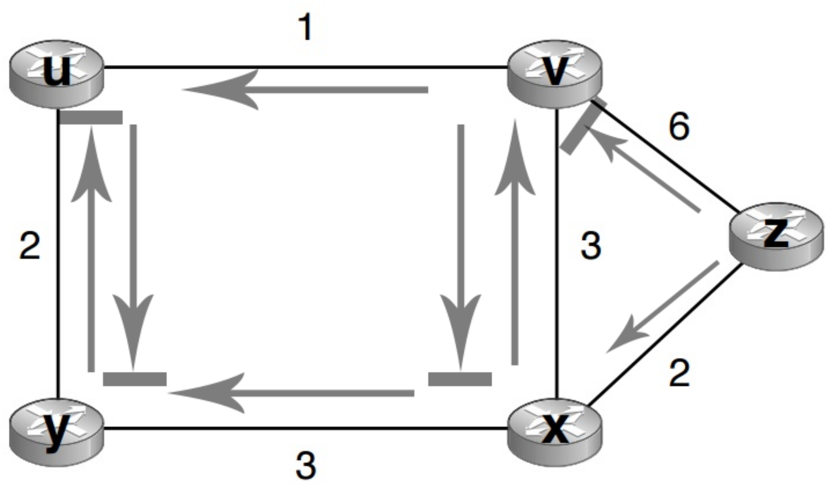
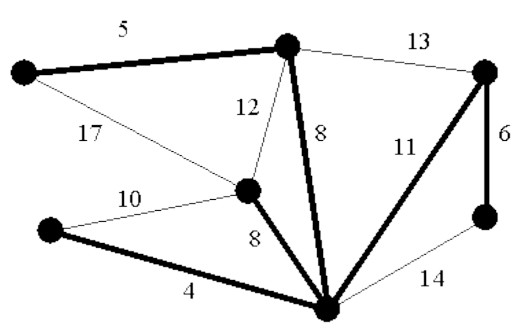
CSE 3461 Homework 4

1. **(8 points**) Consider the topology shown below. Suppose that all links have costs shown in the figure and that node z is the broadcast source. Using arrows below, indicate links over which packets will be forwarded using RPF, and links over which packets will not be forwarded, if node z is the source.



2. **(8 points)** We studied Dijkstra's link-state routing algorithm for computing unicast paths that are individually the least-cost paths from the source to all destinations. The union of these paths might be thought of as forming a **least-unicast-cost** path tree (or a shortest unicast path tree, if all link costs are identical). Construct a counterexample to show that the least-cost path tree is not always the same as a minimum spanning tree.

   Not all least-unicast-cost path trees are minimum spanning trees. Consider this example:



   The above image is a minimum spanning tree. Here the root node is the bottom middle node. In this example, The minimum spanning tree is different from the least-unicast-cost path tree. The least-unicast-cost path tree would have an edge going from the root to the bottom right node since the path cost of the MST route (11+6=17) is higher than the path cost going from the root to the node directly (14).

3. **(6 points)** Suppose the information content of a packet is the bit pattern 1110011010011101 and an even parity scheme is being used. In an even parity scheme the total number of 1s (including the data bits and the parity bit) is even. Compute the parity bits for the case of a 2-dimensional parity scheme if the bits are arranged in a 4x4 table. Assume that the first 4 bits are placed in the first row from left-to-right, the next 4 bits are placed in the next row, and so on.

   1110 **1**
   0110 **0**
   1001 **0**
   1101 **1**
   1100

4. **(6 points)** Consider the CRC generator G = 1001 and answer the following questions:
   a. **(3 points)** Why can it detect any single bit error in data D?

      The generator G=1001 is able to detect single bit errors in D because Cyclic Redundancy Checks can detect all burst errors less than r + 1 bits, which in this case is 9 bits.

   b. **(3 points)** Can the above G detect any odd number of bit errors? Why or why not?

      G cannot detect any odd number of bit errors since the largest burst error it can detect is of size 9 bits.

5. **(6 points)** This problem involves a derivation of the efficiency of slotted ALOHA.
   a. **(3 points)** Recall that when there are N active nodes, the efficiency of slotted ALOHA is $Np(1 - p)^{N-1}$ Find the value of p that maximizes this expression. Show your work.

      $E(p) = Np(1\text{-}p)^{N-1}$
      $E(p) = N(1\text{-}p)^{N-1} \text{-}\ Np(N\text{-}1)(1\text{-}p)^{N-2}$
      $\quad = N(1\text{-}p)^{N-2}((1\text{-}p) - p(N\text{-}1))$
      $E'(p) = 0 \Rightarrow p^* = 1/N$

   b. **(3 points)** Using the value of p found in part (a), find the efficiency of slotted ALOHA by letting N approach infinity. (Hint: $(1 - 1/N)^N$ approaches $1/e$ as N approaches infinity.)
      $E(p^*) = N(1/N)(1\text{-}1/N)^{N-1} = (1 - 1/N)^{N-1} = (1\text{-}1/N)^N/(1\text{-}1/N)$
      $\lim N\text{->}\infty\ (1 - 1/N) = 1$ $\lim N\text{->}\infty\ (1 - 1/N)^N = 1/e$
      Thus
      $\lim N\text{->}\infty\ E(p^*) = 1/e$

6. **(6 points)** On stdlinux, obtain the output of `/sbin/ifconfig -a and /sbin/arp -a`. Submit a printout of the output and explain the output.

```
C:\Users\Sonny {git}
{lamb} ssh -X shisa@stdlinux.cse.ohio-state.edu
shisa@stdlinux.cse.ohio-state.edu's password:
Last login: Sun Oct 18 16:50:38 2015 from d118-75-106-74.col.wideopenwest.com
It is now Mon Nov 16 18:08:30 EST 2015
/home/7/shisa
% /sbin/ifconfig -a
eth0      Link encap:Ethernet  HWaddr 00:50:56:95:20:AA
          inet addr:164.107.113.13  Bcast:164.107.113.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:1234112283 errors:0 dropped:0 overruns:0 frame:0
          TX packets:1049126688 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:437065226084 (407.0 GiB)  TX bytes:1594255881693 (1.4 TiB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:183547699 errors:0 dropped:0 overruns:0 frame:0
          TX packets:183547699 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:48833569990 (45.4 GiB)  TX bytes:48833569990 (45.4 GiB)

/home/7/shisa
% 

ssh.ex... « 140707[32]  1/1  [+] CAPS NUM SCRL PRI‡   (1,1)-(114,30)   114x30 114x1000   3    27   25V  1716 100%,USR
```

ifconfig displays information about the network interfaces currently in operation and the –a flag shows all inactive network interfaces as well

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          collisions:0 txqueuelen:0
          RX bytes:48833569990 (45.4 GiB)  TX bytes:48833569990 (45.4 GiB)

/home/7/shisa
% /sbin/arp -a
hsrp113.cse.ohio-state.edu (164.107.113.1) at 00:23:9c:46:f2:01 [ether] on eth0
/home/7/shisa
%
ssh.ex... « 140707[32]  1/1  [+] CAPS NUM SCRL PRI‡   (1,1)-(114,30)   114x30 114x1000   3    30   25V  1716 100%,USR
```

arp –a shows all the entries of the specified hosts when no hostnames are specified