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Lab 2: Spanning Tree

1. ***Explain the differences between a "hub", a "bridge", and a "router".***

A hub is a dumb active repeater. Packets received on any port are regenerated and distributed to all other ports.

A switch separates multiple collision domains. It dynamically configures the connections between its ports according to an intelligent algorithm. The algorithm, for connections between Port A and Port B, is:

Monitor the traffic on A.
Update the routing table with source addresses from A.
Forward frames destined for stations associated with B.

A bridge is a switch that is capable of translating protocols, e.g., 802.3 on one port and 802.5 on another.

2. ***Answer the questions above.***

<u>Note down the MAC and IP addresses for eth2 of each computer</u>.

```
Computer       MAC                  IP
5a             00:50:fc:57:87:c4    192.168.0.90
5b             00:50:fc:57:87:d1    192.168.0.91
5c             00:50:fc:55:e3:b9    192.168.0.92
5d             00:50:fc:57:87:c2    192.168.0.93
```

Using ethereal to capture icmp packets from A to B with spanning-tree active, the types, addressing and contents were found to be as expected.

Using ethereal to capture icmp packets from A to C with spanning-tree active, the first request/reply pair were as expected. The third frame was an exact copy of the second frame (reply from C to A). The fourth frame had source and destination MAC addresses that are unknown to me, and may have participated in a collision.

One possible explanation is that a reflection of the first reply packet (bounced off Port 1 of Bridge_2) may have collided with the second Request packet sent from A. As a result, the first Reply packet reappeared at Computer C, and the second Request packet finally reached Computer C in corrupted form.

```
Frame 4 (98 on wire, 98 captured)
    Arrival Time: Oct 23, 2004 21:41:40.259025
    Time delta from previous packet: 0.000000 seconds
    Time relative to first packet: 0.990055 seconds
    Frame Number: 4
    Packet Length: 98 bytes
    Capture Length: 98 bytes
Ethernet II
    Destination: 20:20:20:54:79:70 (20:20:20:54:79:70)
    Source: 65:3a:20:49:50:20 (65:3a:20:49:50:20)
    Type: Unknown (0x2830)
Data (84 bytes)

0000  20 20 20 54 79 70 65 3a 20 49 50 20 28 30 78 30      Type: IP (0x0
0010  38 30 30 29 0a 49 6e 74 65 72 6e 65 74 20 50 72   800).Internet Pr
0020  6f 74 6f 63 6f 6c 2c 20 53 72 63 20 41 64 64 72   otocol, Src Addr
0030  3a 20 31 39 32 2e 31 36 38 2e 30 2e 39 30 20 28   : 192.168.0.90 (
0040  31 39 32 2e 31 36 38 2e 30 2e 39 30 29 2c 20 44   192.168.0.90), D
0050  73 74 20 41 64 64 72 3a 20 31 39 32 2e 31 36 38   st Addr: 192.168
0060  2e 30                                             .0
```

3. ***Report your observations for the MAC address tables in step 1.***

On first running the Spanning Tree, the MAC table in Bridge_1 was reported as:

```
Dynamic Address Count:                 2
Secure Address Count:                  0
Static Address (User-defined) Count:   0
System Self Address Count:             49
Total MAC addresses:                   51
Maximum MAC addresses:                 8192
Non-static Address Table:
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  --------------------
0050.fc57.87c4       Dynamic          1  FastEthernet0/1
0050.fc57.87d1       Dynamic          1  FastEthernet0/1
```

Broadcast identification of Computers A and B have resulted in table entries for Bridge_1 on its own Port 1.

After pinging from A to B, the table was unchanged. No bridge forwarding was necessary, since A and B are connected through the hub.

After pinging from A to C, the changed/new table lines are shown below:

```
Dynamic Address Count:                 3
Total MAC addresses:                   52
0050.fc55.e3b9       Dynamic          1  FastEthernet0/2
```

Note that one entry was added to the MAC table, and Counts were updated.
This was the entry for Computer C, and the Bridge has assigned that host to its own Port 2, because the icmp packets were forwarded from Bridge_1 Port 1, to Bridge_1 Port 2.

After pinging from A to D, the changed/new table lines are shown below:

```
Dynamic Address Count:                 4
Total MAC addresses:                   53
0050.fc57.87c2       Dynamic          1  FastEthernet0/2
```

Note that one entry was added to the MAC table, and Counts were updated.
This was the entry for Computer D, and the Bridge has assigned that host to its own Port 2, because the icmp packets were forwarded from Bridge_1 Port 1, to Bridge_1 Port 2.
We see also that Bridge_1 now is aware of every host on our local network, and its associated switch port.

```
A|----| Bridge_1 |-----|C
B|                     |D
```

Bridge_1 is now set up to forward packets from (A or B) on its Port 1, to (C or D) on its Port 2, and vice-versa.

On first running the Spanning Tree, the MAC table in Bridge_2 was reported as:

```
Dynamic Address Count:                 3
Secure Address Count:                  0
Static Address (User-defined) Count:   0
System Self Address Count:             49
Total MAC addresses:                   52
Maximum MAC addresses:                 8192
Non-static Address Table:
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  --------------------
0030.8016.1c81       Dynamic          1  FastEthernet0/1
0050.fc57.87c4       Dynamic          1  FastEthernet0/1
0050.fc57.87d1       Dynamic          1  FastEthernet0/1
```

The origin of the first entry is unknown to me at this time.
Broadcast identification of Computers A and B have resulted in table entries for Bridge_1 on its own Port 1.

After pinging from A to B, the table was unchanged. No bridge forwarding was necessary, since A and B are connected through the hub.

After pinging from A to C, the Bridge_2 MAC table changed:

```
Dynamic Address Count:                 4
Secure Address Count:                  0
Static Address (User-defined) Count:   0
System Self Address Count:             49
Total MAC addresses:                   53
Maximum MAC addresses:                 8192
Non-static Address Table:
Destination Address  Address Type  VLAN  Destination Port
-------------------  ------------  ----  --------------------
0030.8016.1c81       Dynamic          1  FastEthernet0/1
0050.fc55.e3b9       Dynamic        net0/1
```

The spanning-tree algorithm has removed Computers A and B from their previous assignment to Port 1 of Bridge_2. Spanning branches were established from (A to C) and from (B to C), both through Bridge_1. Bridge_2 knows this because of communication between the bridges involved in forming the spanning-tree.

Computer C was assigned to Port 1 of Bridge_2, because Reply icmp packets from Computer C showed up at Port 1 (due to the connection between Port 1 and Hub 1, which senses traffic destined for Computer A).

After pinging from A to D, the MAC table in Bridge_2 was reported as:

```
Dynamic Address Count:                 5
Secure Address Count:                  0
Static Address (User-defined) Count:   0
ount:           49
Total MAC addresses:                   54
Maximum MAC addresses:                 8192
Non-static Address   1  FastEthernet0/1
0050.fc55.e3b9       Dynamic         1  FastEthernet0/1
0050.fc57.87c2       Dynamic         1  FastEthernet0/1
0050.fc57.87c4       Dynamic         1  FastEthernet0/1
0050.fc57.87d1       Dynamic         1  FastEthernet0/1
```

The "extra" table entry has disappeared, but its Count remains.
Computers A and B have reappeared on Port 1 of Bridge_2.
Note that all four hosts are now assigned to Port 1 of Bridge_2.

```
A|
B|----| Bridge_2 |----
C|
D|
```

Bridge_2 can monitor traffic from all 4 hosts, but is not set up to forward packets between its own ports.

4. ***In steps 4 and 5, although there is a physical loop, how is the loop behavior avoided?***

Each switch forwards frames according to the paths established by the spanning tree algorithm. Whether one or both Bridges contain memory of the prior spanning tree, or whether a new tree is constructed from scratch, the result is the same: After repeating the pings with the loop connection made, the MAC table for each Bridge has been rebuilt the same as it was without the loop. The presence of the loop connection is an extraneous path.

5. ***Discuss what you observed in steps 6-8 of the procedure section. Do you think any loop is generated?***

Some console output from Computer A, on pinging Computer C with no spanning-tree active:

```
64 bytes from 192.168.0.92: icmp_seq=2 ttl=255 time=1.226 sec (DUP!)
64 bytes from 192.168.0.92: icmp_seq=2 ttl=255 time=1.226 sec (DUP!)
       ... (many repetitions) ...
64 bytes from 192.168.0.92: icmp_seq=2 ttl=255 time=1.228 sec (DUP!)

--- 192.168.0.92 ping statistics ---
10 packets transmitted, 3 packets received, +12704 duplicates, 70% packet loss
round-trip min/avg/max/mdev = 0.518/609.987/1228.265/354.222 ms
[student@SSU37803 lab02]$

       using ctl-Z to reset:

Warning: time of day goes back, taking countermeasures.
64 bytes from 192.168.0.92: icmp_seq=1 ttl=255 time=990 usec
64 bytes from 192.168.0.92: icmp_seq=1 ttl=255 time=1.052 msec (DUP!)

[2]+  Stopped                 ping -c 10 192.168.0.92
[student@SSU37803 lab02]$
```

Packets kept coming back from Computer C without limit, because they were recirculating along the path among the 2 bridges and 2 hubs. It was necessary to stop the process. Meanwhile, lights on all 4 bridge ports were flashing rapidly - as were the lights on the hub ports connected to Bridge_1.

While these lights continued to flash, 2 pings were issued from A to B:

```
PING 192.168.0.91 (192.168.0.91) from 192.168.0.90 : 56(84) bytes of data.
From 192.168.0.90: Destination Host Unreachable
From 192.168.0.90: Destination Host Unreachable

--- 192.168.0.91 ping statistics ---
2 packets transmitted, 0 packets received, +2 errors, 100% packet loss
```

The panel lights continued to flash, until a loop cable was disconnected.
On pinging again from A to B, the output at A was:

```
PING 192.168.0.91 (192.168.0.91) from 192.168.0.90 : 56(84) bytes of data.
64 bytes from 192.168.0.91: icmp_seq=0 ttl=255 time=236.773 msec
64 bytes from 192.168.0.91: icmp_seq=0 ttl=255 time=236.773 msec (DUP!)
64 bytes from 192.168.0.91: icmp_seq=0 ttl=255 time=246.774 msec (DUP!)
64 bytes from 192.168.0.91: icmp_seq=0 ttl=255 time=436.784 msec (DUP!)
64 bytes from 192.168.0.91: icmp_seq=0 ttl=255 time=436.784 msec (DUP!)
64 bytes from 192.168.0.91: icmp_seq=0 ttl=255 time=436.784 msec (DUP!)

--- 192.168.0.91 ping statistics ---
2 packets transmitted, 1 packets received, +5 duplicates, 50% packet loss
round-trip min/avg/max/mdev = 236.773/338.445/436.784/98.396 ms
```

Monitoring Computer B with ethereal at this time, showed a long stream of request packets from A to C and A to B, followed by many reply packets from C to A, and B to A.

6. ***If so, what is the effect of the loop? You can compare the results in the sections above – with and without the spanning-tree.***
As shown above, the use of the spanning tree with or without a loop path connected, resulted in the orderly transmission of icmp packets between Computer A and the other computers. Without a spanning tree and with the loop path, packets recirculated without end as long as the loop path remained established.