**This is the best assignment solution uploaded with some modification of the following student:**

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## Question No. 1:

a) Suppose a university has a class C network 200.1.1.0 and wants to form subnets for its four departments, with hosts as follows:

Math department 70 hosts
Computer Science department 70 hosts
Engineering department 70 hosts
Chemistry department 35 hosts

Give a possible arrangement of subnet masks to make this possible. Segmentation of hosts of a department and multi-level subnetting is also allowed to achieve this objective.

b) Consider the network in the following Figure, using link-state routing. Suppose the N–R link fails, and the following then occur in sequence:

(a) Node T is added to the right side with a connection to S.
(b) Node P is added to the left side with a connection to O.
(c) A new link P–M is added. The failed N–R link is now restored. Describe what link-state packets will flood back and forth. Assume that the initial sequence number at all nodes is 1, and that no packets time out, and that both ends of a link use the same sequence number in their Link State Protocol for that link, greater than any sequence number either used before.

c) Compute a multicast spanning tree for router Q in the following subnet for a group with members at routers O, P, Q, R, S, T, W, and Y.

d) Consider the network shown in the following Figure, in which horizontal lines represent transit providers and numbered vertical lines are interprovider links.

(a) How many routes to P could provider Q's BGP speakers receive?

(b) Suppose Q and P adopt the policy that outbound traffic is routed to the closest link to the destination's provider, thus minimizing their own cost.

What paths will traffic from host A to host B from host B to host A take?

(c) What could Q do to have the B → A traffic use the closer link 1?

(d) What could Q do to have the B → A traffic pass through R?

## Solution:

**a)**

Math Dept subnet mask: 255.255.255.192 and accommodate 63 hosts with subnet number 200.1.1.0

CS Dept subnet mask: 255.255.255.192 and accommodate 63 hosts with subnet number 200.1.1.64

Engg Dept subnet mask: 255.255.255.192 and accommodate 63 hosts with subnet number 200.1.1.128

Subnet number 200.1.1.192 with subnet mask: 255.255.255.192 will go to a router where further subnetting is done as below:

Chemistry Dept subnet mask: 255.255.255.224 and accommodate 31 hosts with subnet number 200.1.1.192

Subnet number 200.1.1.224 with subnet mask: 255.255.255.224 will go to a router where further subnetting is done as below:

Additional Math Dept subnet mask: 255.255.255.248 and accommodate remaining 7 hosts with subnet number 200.1.1.224

Additional CS Dept subnet mask: 255.255.255.248 and accommodate remaining 7 hosts with subnet number 200.1.1.232

Additional Engg Dept subnet mask: 255.255.255.248 and accommodate remaining 7 hosts with subnet number 200.1.1.240

Additional Chemistry Dept subnet mask: 255.255.255.248 and accommodate remaining 4 hosts with subnet number 200.1.1.248

**b) Consider the network in the following Figure, using link-state routing. Suppose the N–R link fails, and the following then occur in sequence:**

**(a) Node T is added to the right side with a connection to S.**

**(b) Node P is added to the left side with a connection to O.**

**(c) A new link P–M is added. The failed N–R link is now restored. Describe what link-state packets will flood back and forth. Assume that the initial sequence number at all nodes is 1, and that no packets time out, and that both ends of a link use the same sequence number in their Link State Protocol for that link, greater than any sequence number either used before.**

**Assumptions**

- We will use OSPF-style numbering here.
- Each node increments its sequence number only when there is some change in the state of its local links
- No Packets time out
- The "bringing-up-adjacencies" process in restoring the connection between the left- and right-hand networks; it is not sufficient simply to flood the information about the restored link. The two halves have evolved separately, and full information must be exchanged.

**OSPF**

- OSPF routers send out one LSP, with one sequence number, that describes the entire router's connections;
- The routers do not send out a different LSP (or at least different LSA) for each link, each with its own sequence number.

Since each node increments its sequence number whenever it detects a change in its links to its neighbors, therefore, at the instant before the N—R link is restored the Link State Protocol (LSP) data for each node can be given as follows:

| Node | Sequence No. | Connects to |
|---|---|---|
| M | 2 | N, O, P |
| N | 2 | M, O |
| O | 2 | M, N, P |
| P | 2 | M, O |
| R | 2 | S |
| S | 2 | R, T |
| T | 1 | S |

When the N–R link is reestablished, OSPF has N and R exchange their full databases of all the LSPs they have seen with each other.

Each of N and R then floods the other side's LSPs throughout its side of the network that is retorted now. These LSPs are given in the above table, except that N and R now each have

sequence numbers of 3. If we would have assigned separate sequence numbers to each individual link, then every sequence number would be 1 except for link N—R. The initial sequence number of an OSPF node is $2^{31} + 1$.

**c) Compute a multicast spanning tree for router Q in the following subnet for a group with members at routers O, P, Q, R, S, T, W, and Y.**

The mutlicast spanning tree for router Q in the given subnet for a group with members at routers O, P, Q, R, S, T, W, and Y is not unique. There are many spanning trees that can be computed from the given subnet. However, one of the many possible spanning trees is given as under:

**d) Consider the network shown in the following Figure, in which horizontal lines represent transit providers and numbered vertical lines are interprovider links.**

**(a) How many routes to P could provider Q's BGP speakers receive?**

**(b) Suppose Q and P adopt the policy that outbound traffic is routed to the closest link to the destination's provider, thus minimizing their own cost. What paths will traffic from host A to host B from host B to host A take?**

**(c) What could Q do to have the B → A traffic use the closer link 1?**

**(d) What could Q do to have the B → A traffic pass through R?**

**(a) How many routes to P could provider Q's BGP speakers receive?**

Provider Q's BGP speakers will receive three (3) routes to P as follows:

- Along link 1 (represented by red colored line in the figure)
- Along link 2 (represented by green colored line in the figure)
- Along link 3 (represented by blue colored line in the figure)

**(b) Suppose Q and P adopt the policy that outbound traffic is routed to the closest link to the destination's provider, thus minimizing their own cost. What paths will traffic from host A to host B and from host B to host A take?**

The path that traffic from host A to host B will take is link 1 i.e. A → B: Link 1
The path that traffic from host B to host A will take is link 2 i.e. B → A: Link 2
This will reduce cost to the source of the traffic. The following figure illustrates the paths that traffic from host A to host B and from host B to host A will take:
A → B: Link 1 (represented by blue colored line in the figure)
B → A: Link 2 (represented by green colored line in the figure)

**(c) What could Q do to have the B → A traffic use the closer link 1?**

To have the B → A traffic use the closer link 1, Q can be configured to prefer link 1 instead of link 2 in all cases. A general solution for Q is to accept some of the internal structure of P into its routing table. In this way, it is easy to know where a host is located relative to the links 1 and 2.

**(d) What could Q do to have the B → A traffic pass through R?**

There are two solutions for Q to have the B → A traffic pass through R as follows:

- Q can be reconfigured to prefer the Autonomous Systems path through R
- Q can be reconfigured to avoid the Autonomous Systems paths involving links 1 and 2. This strategy leaves the route to P through R as the only route and now the B→A traffic will pass through R.

## Question No. 2:

Read the attached research paper entitled "Network Virtualization: State of the Art and Research Challenges" with this assignment very carefully. Answer the following questions:

1. **In context of next-generation networking paradigm which architectural principles are considered in Network Virtualization?**
2. **Which key issues to be resolved for realization of Network Virtualization Environments?**

## Solution:

**Please! Consult the mentioned Research Paper.**

## Question No. 3:

Read the attached Lecture Notes by Hari Balakrishnan, "Interdomain Internet Routing," MIT Lecture Notes with this assignment very carefully. Answer the following questions:

1. **What are the motivation factors in terms of requirements affect the design of BGP.**
2. **Differentiate between Exporting and Importing Routers discussed in this Lecture.**
3. **How Pakistan Telecom Authority (PTA) diverted YOUTUBE access and data traffic on February 24, 2008?**
4. **Differentiate between eBGP and iBGP ?**
5. **Point out the goals that BGP doesn't support properly as discussed in this lecture.**

## Solution:

**Please! Consult the mentioned Lecture Notes.**

## Question No. 4:

Consider the following topology:

Each link is a duplex link with 10Mb bandwidth and 5msec delay. Node 2 sends UDP data to node 4 with packet size of 500 bytes and 200 packets per second. Node 2 starts sending data at time 1.0 sec. At time 4.0 sec, link from node 3 to 4 goes down and re-establishes at 8.0 sec. Simulation halts at 10.0 seconds. When a link from source to destination fails the network must take alternative path. Create a trace file for the simulation and execute NAM to view the simulation.
Write Tool Command Language (TCL) script for the above simulation scenario in file 'assign3cs716.tcl'.

## Solution:

Please! Find the attached file with RAR having required .tcl file.