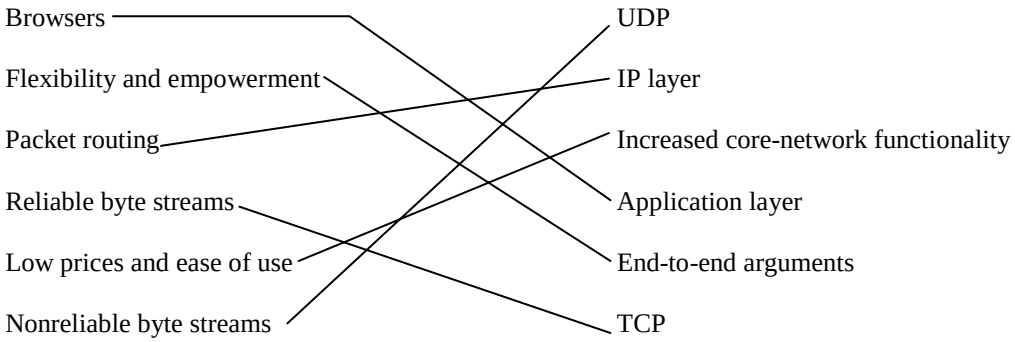
Solutions to Homework 1

1. INTERNET ARCHITECTURE (30 points)

For 5 points each, match each item in the left-hand column with the item in the right-hand column with which it is most closely associated.



2. INFORMATION ECONOMY (20 points)

a. (5 points) Network effects (or network externalities).

b. (5 points) False.

c. (5 points) The following answers are all acceptable; they are taken from Chapter 1 of *Information Rules*:

- Value-based pricing
  - Differential pricing
  - Versioning
- Legal protection (*e.g.*, copyright)
- Other business strategies, *e.g.*, branding

Other reasonable answers will be given full credit, including:

- Technical-protection services
- Yet other business strategies, *e.g.*, bundling

d. (5 points) Bundling.

3. DIGITAL CONTENT DISTRIBUTION (20 points)

a. (5 points) All of the businesses involve *giving away content* in the hopes of making money some other way (perhaps by selling related content).

b. (5 points) 4: All of the above.

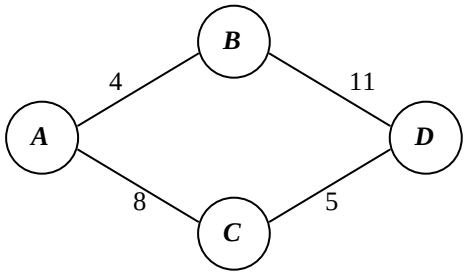
c. (5 points) 2: The copyright owner's exclusive right to prepare derivative works based upon the copyrighted work (number 2 of Section 106 of U.S. Copyright Law).

d. (5 points) No.

4. ROUTING (30 points)

I. OSPF Routing

a. From the LSPs, we see that the network looks like the following:



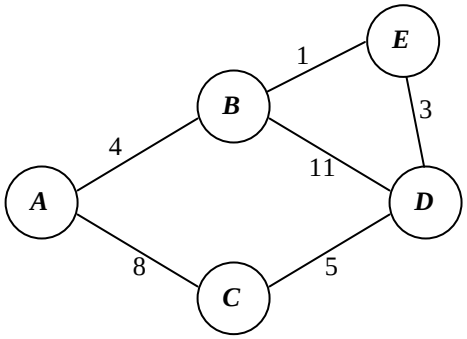
The shortest paths (paths of minimum total weight) from ***A*** to the other nodes are:

Destination	Path	Total Cost
A→B	***A→B***	4
A→C	***A→C***	8
A→D	***A→C→D***	13

So the forwarding table for ***A*** is:

Destination	Next Hop
B	***B***
C	***C***
D	***C***

b. From the updated LSPs we get the following network:



The shortest paths from ***A*** to the other nodes are:

Destination	Path	Total Cost
A→B	***A→B***	4
A→C	***A→C***	8
A→D	***A→B→E→D***	8
A→E	***A→B→E***	5

So the forwarding table for ***A*** is:

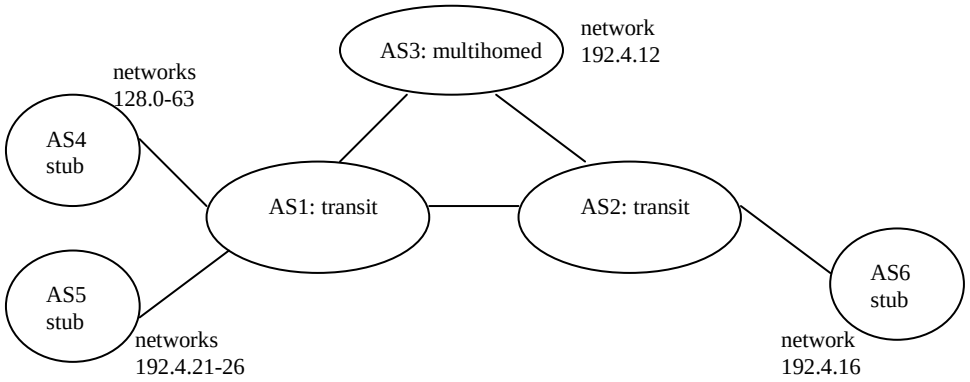
Destination	Next Hop
B	***B***
C	***C***
D	***B***
E	***B***

Note that, in addition to the new entry, the next hop for ***D*** also changes.

c. When these link costs are set to zero, almost all the traffic in the network (*i.e.*, all except the traffic between ***C*** and ***D***) will be sent through ***B***, because the nodes think that those links are free. As a result, ***B*** might get overwhelmed with network traffic and become a bottleneck.

Note: It may not be necessary to re-draw the entire network and calculate all the shortest paths to compute an updated forwarding table; in fact, routers do not do this. The complete steps are shown above to make the answers clearer.

II. BGP Routing



d. AS1 is a transit AS; so it will carry traffic through it to other AS's connected to it. Because BGP speakers advertise complete, loop-free paths to networks, AS1 sends out the following information:

- networks 128.0-63 are reachable through <AS1, AS4>
- networks 192.4.21-26 are reachable through <AS1, AS5>
- network 192.4.12 is reachable through <AS1, AS3>
- network 192.4.16 is reachable through <AS1, AS2, AS6>

e. Because AS3 is a multihomed AS, it does not accept transit traffic. Therefore it would only advertise that it contains the network 192.4.12.

f. AS1 has to change its reachability information for AS3, because the link is down. AS3 is still reachable through AS1, however, and the new path needs to be advertised so that the stubs connected to AS1 (*e.g.*, AS4, AS5) will know how to reach networks in AS3. The new advertisement is:

- networks 128.0-63 are reachable through <AS1, AS4>
- networks 192.4.21-26 are reachable through <AS1, AS5>
- network 192.4.12 is reachable through <AS1, AS2, AS3>
- network 192.4.16 is reachable through <AS1, AS2, AS6>