1.)

Routing is the process of finding a path from a sender to a destination upon which a packet travels that meets certain criteria.

Forwarding is the process of sending the packet along that path from the sender to the destination.

2a.)

Packet loss can occur at input ports due to HOL blocking. This happens when two input ports are competing for use of a single output port. This can fill up buffers and cause packet losses during periods of high traffic. This can be avoided using the Bimodal Multicast algorithm which uses a gossip protocol to eliminate HOL blocking but also is more tolerant to out of order delivery. Another way to avoid this is to increase buffer sizes and make output ports able to handle more traffic than input ports.

2b.)

Packet loss can occur at output ports when datagrams arrive from fabric faster than the transmission rate of the port. This can happen if 2 TCP connections are using the same output port. If both TCP connections spike their transmission rates at the same time the bandwidth required is much greater than the average over the course of the connection. This can fill up buffers very fast and can cause large numbers of packets to be dropped. This can be mitigated with AQM algorithms that drop packets before the buffer is full to slow down tcp threads before having to drop many more packets when the buffer fills completely.

3a.)

Destination address	Interface
224.0.0.0/10	0
224.64.0.0/16	1
224.0.0.0/8	2
225.0.0.0/9	2
0.0.0.0/0	3

3b)

Addr1: 200.145.81.85

The table sees that this address does not match the first 10 bits of 224.0.0.0, the first 16 bits of 224.64.0.0, the first 8 bits of 224.0.0.0, or the first 9 bits of

225.0.0.0. Therefore the tables determine that the correct interface is 3 because it matches no other entry in the table except for the first 0 bits of 0.0.0.0.

Addr2: 225.64.195.60

The table sees that this address does not match the first 10 bits of 244.0.0.0, the first 16 bits of 244.64.0.0, the first 8 bits of 244.0.0.0, but it does match the first 9 bits of 245.0.0.0. Therefore the tables determine that the correct interface is 2 because that is the only table entry that the address matches.

Addr2: 225.128.17.119

The table sees that this address does not match the first 10 bits of 244.0.0.0, the first 16 bits of 244.64.0.0, the first 8 bits of 244.0.0.0, but it does match the first 9 bits of 245.0.0.0. Therefore the tables determine that the correct interface is 2 because that is the only table entry that the address matches.

4a)

Routers are parts of autonomous systems where all routers in that autonomous system are using the same intra-AS protocol. This allows for seamless communication inside of all autonomous systems. Autonomous systems communicate with each other via specialized gateway routers which implement inter-AS protocols. The problem of scalability is solved because the only routers that non gateway routers need to worry about are the routers within their AS. The only routers that gateway routers need to worry about are the gateway routers for the other autonomous systems. This structure is very scalable due to the fact that any given router does not need to worry about every other router in the internet but rather a small subset of routers.

4b)

A variety of inter and intra AS systems helps to solve scalability. If all routers ran the same routing protocol the routing information that would need to be dispersed around the network would be far too much for the network to handle. The computing time to create and interpret this information would also become too great. Also the many different companies that own servers might want to implement their own protocols on their machines. These protocols can be tailor made to save a specific company money based on the layout and size of their network. This means that a single protocol to handle all layouts and sizes of networks is impractical.

5a)

eBGP

5b)

iBGP

5c)

iBGP

5d)

I1. This is because I1 is the first edge in the lowest cost path to 4a, which passes through 1c. In the case of I2 the path would still need to go through 1a because there is no other path to get to 4a. So I2 would add an extra unneeded hop to the path.

5e)

I2. The I2 path gets the data out of the AS in less hops so it is chosen over I1.

6.)

Node z		Cost To				
		v	x	y	u	z
Cost From	v	∞	∞	∞	∞	∞
	x	∞	∞	∞	∞	∞
	y	∞	∞	∞	∞	∞
	u	∞	∞	∞	∞	∞
	z	6	3	∞	∞	0

Node z		Cost To				
		v	x	y	u	z
Cost From	v	0	3	∞	1	6
	x	3	0	3	∞	2
	y	∞	3	0	2	∞
	u	1	∞	2	0	∞
	z	5	3	∞	∞	0

Node z		Cost To				
		v	x	y	u	z
Cost From	v	0	3	3	1	5
	x	3	0	3	4	2
	y	3	3	0	2	5
	u	1	4	2	0	7
	z	5	3	5	6	0

Node z		Cost To				
		v	x	y	u	z
Cost From	v	0	3	3	1	5
	x	3	0	3	4	2
	y	3	3	0	2	5
	u	1	4	2	0	6
	z	5	3	5	6	0

7.)

The number of steps needed to complete the distance vector algorithm are based off of the number of edges in the network. The table is filled after a finite amount of steps based the two nodes that are furthest away from each other. Once a non infinite value is in the table the only line of code that can update a non infinite value is this: $D\_x(y) = min\_v\{c(x,v) + D\_v(y)\}$. Because this line of code is taking the minimum of the current value and the value of an alternate path it is impossible for the value in the table to increase. Since the algorithm will only update path cost values if a lower value exists through an announcing node and since the number of different paths are finite, the table must be completed within a finite number of steps.