**CPE 490A Final Exam – Fall 2024**

**Honor Code: I pledge my honor that I will abide by the Stevens Honor System.**

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**Signature**\_Jason McCauley\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_(Type your name as Signature)

Note: Please **Print** or **Type** your answer clearly. There are 10 questions.

1. **(10 points)** List the desired properties that a good routing algorithm should have.

A good routing algorithm should be correct and simplistic. Additionally, it should be robust, in that the routing algorithm should be able to cope with changes in topology and traffic due to hardware and software failures. Furthermore, the routing algorithm should be stable, in that it should converge to equilibrium and stay there after some running time. Lastly, a good routing algorithm should exhibit fairness and optimality.

1. **(10 points)** List the routing algorithms that you know.

Routing algorithms include shortest path routing, distance vector routing, link state routing, hierarchical routing, broadcast routing, multicast routing, routing for mobile hosts, and routing in ad hoc networks.

1. **(10 points)** What are the features of Mobile Ad hoc Networks?

Mobile Ad hoc Networks assume no fixed base station. Additionally, they are formed by moving nodes, for instance, mobile computers. Furthermore, they utilize multi-hop connections, and when a neighbor moves away or is out of power, links between that neighbor are broken. It is also worth noting that the nodes in a Mobile Ad hoc Network serve as a host as well as a router. Lastly, their topology changes dynamically, as they have no fixed infrastructure.

1. **(10 points)** What are the General Principles of Close-loop Congestion Control?

The first principle of Close-loop Congestion Control is to monitor the system. By doing this, you can detect when and where congestion is occurring, and this can be quantified through metrics, such as the percentage of dropped packets, average queue length, and average packet delay. The second principle is passing information to where action can be taken. This can be accomplished by the router sending a packet to the traffic source. The third principle is to correct the problem by adjusting system operation, namely, reducing traffic volume.

1. **(10 points)** What are the techniques for achieving good quality of service?

One technique for achieving good quality of service is over-provisioning, or providing more router capacity, buffer space, and bandwidth. The only downside of this is that it is expensive. Another technique for achieving good quality of service is buffering. Flows can be buffered on the receiving side before being delivered. Furthermore, this does not affect reliability and bandwidth whatsoever, but increases delay, ultimately reducing the jitter. Additionally, a technique for achieving good quality of service is traffic shaping, which makes the server transmit at a uniform rate. Furthermore, by regulating the average rate of data transmission, traffic shaping smoothes out traffic on the server side. One algorithm that achieves this is the Leaky Bucket Algorithm, which produces a rigid output pattern. Another algorithm is the Token Bucket Algorithm, where the output rate may change depending on the incoming traffic bursts.

1. **(10 points)** List and briefly explain the five types of OSPF messages.

The five types of OSPF messages are Hello, which is used to discover who the neighbors are, Link state update, which provides the sender’s costs to its neighbors, Link state ack, which acknowledges the link state update, Database description, which announces which updates the sender has, and Link state request, which requests information from the partner.

1. **(10 points)** List and briefly explain the five primitives for a transport service.

The five primitives for a transport service are LISTEN, which doesn’t send a packet and blocks until some process tries to connect, CONNECT, which sends a CONNECTION REQ. packet and actively attempts to establish a connection, SEND, which sends a DATA packet and sends information, RECEIVE, which doesn’t send a packet and blocks until a DATA packet arrives, and DISCONNECT, which sends a DISCONNECTION REQ. packet and wants to release the connection.

1. **(10 points)** List five applications that use TCP.

Five applications that use TCP are FTP for file transfer, Telnet for remote login, SMTP for e-mail, Finger for looking up info about a user, and HTTP for the World Wide Web.

1. **(10 points)** DNS uses UDP instead of TCP. If a DNS packet is lost, there is no automatic recovery. Does this cause a problem, and if so, how is it solved?

If a DNS packet is lost, it does cause a problem, because UDP does not have automatic packet recovery. However, this problem is usually resolved, because if the DNS resolver does not receive a response within a certain timeout period, it will retransmit the DNS query. Additionally, if the first DNS query fails, the resolver will retry the same query multiple times, as well as try querying other DNS servers. Additionally, the DNS resolver will use an exponential backoff strategy, increasing wait time between query attempts. Ultimately, these retry mechanisms allow for a reasonable chance of successful resolution.

1. **(10 points)** List the fields of a DNS resource record, and explain the meaning of each field.

The first field of a DNS resource record is the Domain Name, which is the specific domain name that the record belongs to, for example, flits.cs.vu.nl. The second field is Time to Live (TTL), which indicates how long the DNS resolver, in seconds, can cache the record before needing another copy, for instance 3600 (1 hour). The third field is Class, which for typical domain records is almost always “IN” for internet info. The fourth field is Type, which specifies the type of DNS record. If Type is A, for instance, that indicates Address, and that the domain name is being mapped to an IPv4 address. Other Types include MX for mail exchange, NS for name server, PTR for pointer. The fifth field is Value, which is the actual data corresponding to the Type for the DNS resource record. For instance, if Type is A, the Value field could look like 192.31.231.165.