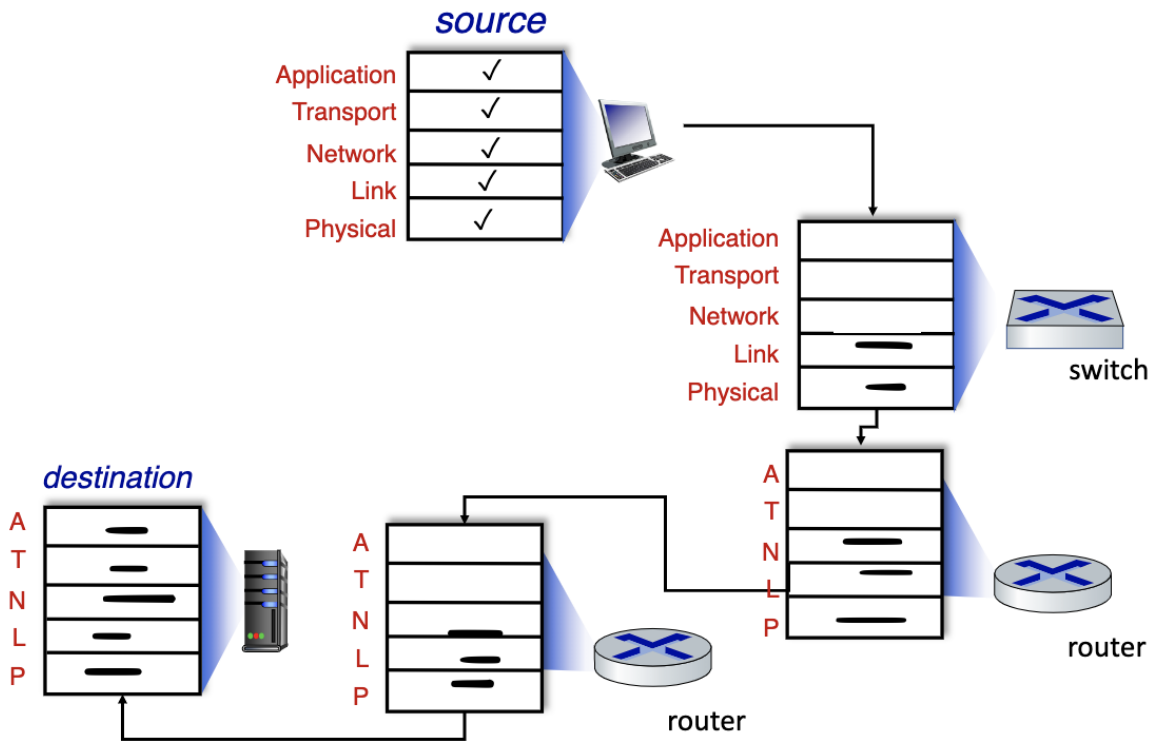
1. **2.412 ms**
    - You to router:
        - Speed = 10mbps, Time = 1500*8 bits / 10e5 bits/sec = 1.2ms
    - router to router:
        - Speed = 1gbps, Time = 1500*8 bits / 10e8 bits/sec = .012ms
    - Router to friend:
        - Speed = 10mbps, Time = 1500*8 bits / 10e5 bits/sec = 1.2ms
    - Total = 2.412 ms

2. **No**
    - Circuit Establishment Delay= 10ms
    - Throughput = min(link1, link2, link3) = 10mbps
    - Transmission delay = L/R = 1500*8 bits / 10e5 bits/second = 1.2ms
    - Total Time= 11.2 ms, takes more time than 1).
3. **Packet Switched**
    - Circuit Switched Scenario:
        - Circuit Establishment Delay= 10ms
        - Time for one packet = 1.2ms
        - Time for 100 packets = 100 * 1.2ms = 120ms
        - Total = 130ms
    - Packet Switched Scenario:
        - A packet can be sent every 1.2 ms from the origin due to minimum link speed
        - 100*1.2 + time for last packet to finish running through the next two wires (120ms + 1.212ms) = 121.212ms
4. **3.9724 seconds**
    - The time for a packet to reach the destination is less than the delay between each packet, so the time it takes one person to send all of their packets is 20ms * 99 = 2000ms. Time to send last packet is 1.5ms
    - In a circuit network, one friend must finish sending all of their packets before the other one starts.
    - Total time = 2(5ms + 1980ms + 1.2ms) + 4.0124s
5. **1.9824 seconds**
    - Two friends both send packets in the time it takes to create a packet since the send time is less than half of 20ms. The last packets will be sent after 2(1.2)ms.
    - Total = 99(20ms) + 2(1.2)ms = 2.0024
6. **42.42 ms**
    - Total = propagation delay + transmission delay
    - Propagation delay = d/s = 10002km / 2.5e8 m/s = .040008s = 40.008ms
    - Transmission delay = 2.412 ms
    - Total = 42.42 ms
7. **((n-1)/2) * (L/R)**
    - If there are n packets in a queue at one time, there will be (0 + 1 + 2 … n-1) * L/R waiting time.

8. Answers below
    - **a) 1,800 km**
        - Max distance = min(Propagation speed * time)
        - 3*10^8 * 12ms = 3.6m km
        - RTT so divide by 2
    - b) **The results at hop number 9 are not consistent meaning that the 15ms measurement could have been conducted at a time where there was a high amount of traffic at the time. The measurements of 13 at hop number 14could reflect measurements taken at a time where the traffic was low at hop number 9**
9. Answers below
    - a) 1mbps
        - Throughput = min(all links)
    - b) 1mbps
        - Minimum link is still 1mbps
    - c) Queuing delay increases
        - After each of the packets go through the 100mbps link, they will sit in the queue as they are being processed on the 1 mbps link.
10.



    -
    - 2 + 10 + 20 + 20 + 18 = 70bytes
    - 2/68+1024 = 0.0018315

Part 2

1.

a.

```
48 1.775102    2610:148:1f00:0:f5…  2606:2800:220:1:24…  HTTP     652 GET / HTTP/1.1
50 1.795768    2606:2800:220:1:24…  2610:148:1f00:0:f5…  HTTP    1108 HTTP/1.1 200 OK  (text/html)
```

b. The request to the link https://www.cc.gatech.edu/~dhekne/cs3251/hw1.html uses the HTTPS protocol while the first request uses the HTTP protocol.

2.

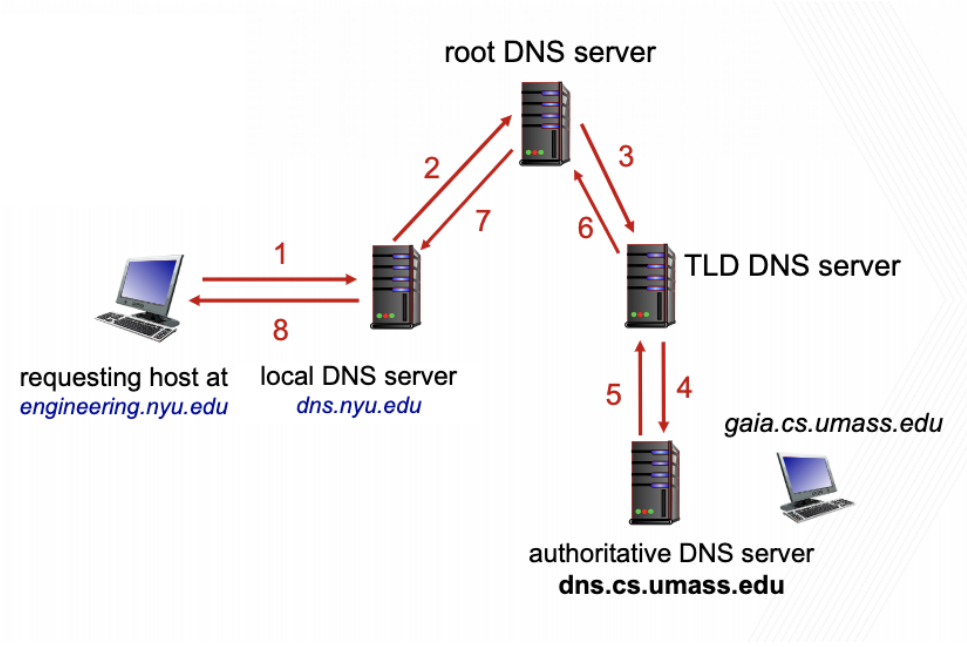
a. You would use non-persistent HTTP connections because the time for a Wikipedia article to return is much less than the time it takes to read one. This would result in a persistent connection when you are not using most of the time.

b. A persistent connection would help because each request to the HTTP server will only take one RTT instead of two with a non-persistent connection. You would have to wait 30 minutes or RTT.

3. You should use a persistent connection because each referenced object (in this case, an image) will take 1 RTT instead of 2RTT.

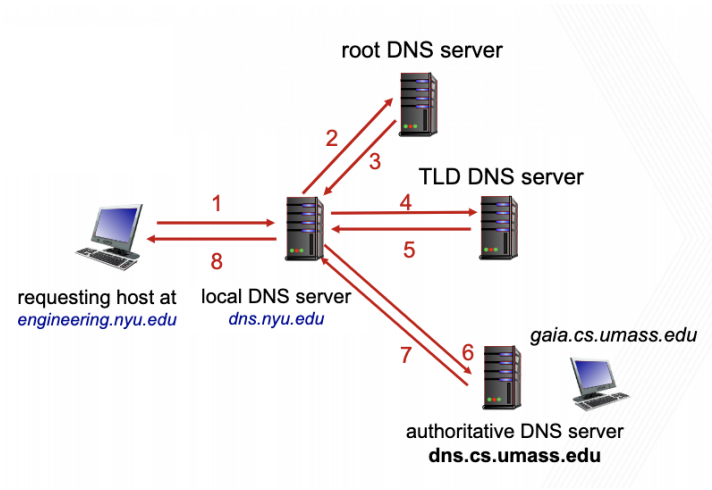
4. The client will send a message to the local DNS server. The local DNS will send a message to the root DNS server. The root DNS server will send a message to the TLD DNS (.edu) server. The TLD DNS server will send a message to the authoritative DNS server (gatech.edu). The IP address is found and sent back through the TLD DNS server back to the root DNS server to the local DNS server and back to the client.

a.



5. The client will send a message to the local DNS server. The local DNS server will send a message to the root DNS server and will receive back a message. The local DNS server will then send a message to the TLD DNS server and will receive a message back. The local DNS will send a message to the authoritative DNS server and receive a message back. The local DNS server will now send the corresponding IP back to the client.

a.



b. The tradeoffs are that for the iterative access method, the load is put on the local DNS server while for the recursive scenario, the load is put in the root DNS server.