

# Data Communication and Computer Networks (CS536)

## Lab 1

Student Name: Chandrika Mukherjee

Student ID: 0032808289

Email: cmukherj@purdue.edu

### Bonus Problem

Round-trip time (RTT) is the time duration for a network request to reach from a sender to destination, and receiving acknowledgement from the receiver to sender. Therefore, same distance is covered twice.

**Calculation of lower bound of RTT:**

$$Speed = Distance/Time$$

While sending data and receiving acknowledgement, the straight line distance between the sender and receiver is covered twice.

Therefore, the formula of lower bound of RTT with respect to SOL (speed of light) :

$$RTT = 2 * Distance/SOL$$

Distance is taken as straight line distance of the receiver from Computer Science Department of Purdue University.

RTT is obtained using ping application.

$SOL = 186,000$  miles/sec or 186 miles/ms

Places	Destination	Distance (miles)	Lower Bound RTT (ms)	Obtained RTT (ms)
Purdue	www.cs.purdue.edu	0.67	0.0072	0.363
IUPUI	www.iupui.edu	62	0.66	4.100
Midwest	www.osu.edu	207	2.225	5.996
East Coast	www.columbia.edu	679.51	7.3065	24.802
West Coast	www.berkeley.edu	1890.87	20.33	51.933
Across Atlantic	www.ua.pt (Portugal)	3964.83	42.63	140.013
Across Pacific	www.tsinghua.edu.cn (China)	6698.11	72.02	205.306

## Observations:

- **Purdue:** Obtained RTT (0.363 ms) is much higher than the calculated lower bound of RTT (0.0072 ms). The physical distance is the least among all other destinations, but RTT is higher for this connection. This discrepancy may occur due to high traffic in network. As the sender is in Purdue and the receiver is also in Purdue and many other people (Purdue student, professors, employees etc.) are utilizing same network. Therefore, network is congested with high levels of traffic that results in higher RTT value. But this factor can be eliminated for other destinations as the number of data packets reaching those destinations from Purdue at a particular time will be less or almost none.
- **IUPUI:** Obtained RTT (4.1 ms) is quite equivalent to the lower bound (0.66 ms) but still higher. This can happen because of transmission medium (copper wire, fiber optic cables). Also, the number of hops can be another factor, as higher number of hops will increase RTT.
- **Midwest:** For Ohio State University, Obtained RTT(5.996 ms) is very close to lower bound of RTT (2.225 ms). This result suggests that the route of data flow is probably straight line which matches with our lower bound calculation.
- **East Coast:** Distance of Columbia University from Purdue University is higher than last three destinations. obtained RTT is almost 3.4 times the lower bound RTT. The communication way is probably not in straight line, involves more hops that increases RTT value. To match the obtained RTT, the physical distance has to be almost 2306.586 miles.
- **West Coast:** Distance of University of California, Berkeley from Purdue University is even higher than previous four universities. Obtained RTT is only twice the lower bound. This can suggest that the data flow is happening in straight line and there are less number of hops in that path. The RTT may vary little bit because of transmission medium or server response time.
- **Across Atlantic:** The distance of University of Aveiro of Portugal from Purdue University is 3964.83 miles. Obtained RTT (140.013ms) is much higher than lower bound of RTT (42.63 ms). This suggests that the communication way is not straight line, but involves indirect route or more number of hops that results in higher RTT. To match the obtained RTT, the distance of the destination has to be 13021.209 miles from Purdue University. This certainly implies that here the major factor in high RTT is complex communication route.
- **Across Pacific:** The distance of Tsinghua University at China from Purdue University is 6698.11 miles which is higher than previous 6 destinations. Obtained RTT (205.3 ms) is much higher than lower bound of RTT(72.02 ms). This also suggests that the communication way is not straight line, but involves indirect route or more number of hops that results in higher RTT. To match the obtained RTT, the distance has to be 19093.458 miles. This certainly suggests that the major contributing factor in high RTT is complex communication route.