Lab5 : Final Report
ECE 658: Internet Engineering

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In this lab, Chord Protocol is implemented and tested with 20 and 40 PlanetLab Nodes. Following are the results:-

1 For Network Scale : 20 Nodes

1.1 Search Results

20 PlanetLab nodes are set up and they share their file details. A search request is issued from a text file and the following results are obtained:-

Query Request	Found	Search 1		Search 2		Search 3		Search 4		Search 5	
		Latency 1	Hop 1	Latency 2	Hop 2	Latency 3	Hop 3	Latency 4	Hop4	Latency 5	Hop 5
Twilight	yes	0.1	2	0.6	4	0.1	2	0.0	0	0.1	2
Jack	yes	0.1	3	0.8	5	0.2	3	0.1	8	0.1	1
American Idol	yes	0.1	3	0.3	2	0.2	4	0.1	4	0.2	4
Happy Feet	no	0.1	2	0.3	2	0.1	2	0.0	2	0.2	3
Twilight saga	no	0.2	5	0.2	1	0.0	0	0.1	6	0.0	0
Happy Feet	no	0.1	2	0.3	2	0.1	2	0.0	2	0.2	3
Happy Feet	no	0.1	2	0.3	2	0.1	2	0.0	2	0.2	3
Feet	no	0.0	1	0.6	4	0.3	6	0.0	0	0.0	0
Happy Feet	no	0.1	2	0.3	2	0.1	2	0.0	2	0.2	3
Twilight	yes	0.1	2	0.6	4	0.1	2	0.0	0	0.1	2
Windows	yes	0.3	6	0.6	4	0.5	9	0.1	6	0.4	6
Happy Feet	no	0.1	2	0.3	2	0.1	2	0.0	2	0.2	3
Mission Impossible	yes	0.4	8	0.0	0	0.1	2	0.1	4	0.1	2
Twilight	yes	0.1	2	0.6	4	0.1	2	0.0	0	0.1	2
Windows 8	no	0.0	0	0.4	8	0.0	1	0.0	0	0.1	1
The	yes	0.2	4	0.2	4	0.1	3	0.0	1	0.0	0
Happy	no	0.1	2	0.1	2	0.2	4	0.1	2	0.3	5
Windows 8	no	0.2	3	0.0	1	0.0	0	0.0	0	0.3	4
Happy Feet	no	0.1	1	0.1	3	0.0	0	0.2	5	0.2	2
Super Mario	yes	0.4	6	0.0	1	0.3	6	0.1	3	0.6	8
Jack and Jill	yes	0.1	2	0.2	5	0.2	5	0.0	1	0.2	3
Happy Feet	no	0.1	2	0.3	2	0.1	2	0.0	2	0.2	3
Impossible	yes	0.4	6	0.1	2	0.0	0	0.1	2	0.7	9
Happy Feet	no	0.1	2	0.3	2	0.1	2	0.0	2	0.2	3
Turn Up The Music	yes	0.2	3	0.1	3	0.3	6	0.0	1	0.3	4
Adventures of Tintin	yes	0.3	4	0.2	4	0.0	0	0.1	3	0.1	1
Twilight saga	no	0.6	9	0.0	0	0.0	0	0.1	2	0.0	0
Happy Feet	no	0.1	2	0.3	2	0.1	2	0.0	2	0.2	3
Super Mario	yes	0.6	9	0.2	4	0.2	4	0.0	0	0.2	2
American Pickers	yes	0.3	4	0.3	6	0.0	1	0.1	1	0.5	6
Microsoft Office 2010	no	0.2	3	0.1	2	0.1	2	0.0	0	0.0	0
The Silver Linings Playbook	no	0.1	2	0.1	1	0.0	1	0.2	2	0.1	1
Breaking Dawn	yes	0.0	0	0.1	1	0.1	2	0.5	6	0.6	7
Gangster Squad	no	0.0	0	0.3	4	0.1	3	0.4	5	0.4	5
Ted	no	0.0	0	0.4	6	0.0	1	0.0	0	0.7	9
Magic Mike	no	0.5	4	0.1	1	0.0	1	0.1	1	0.1	1
Abraham Lincoln: Vampire Hunter	no	0.4	3	0.2	3	0.0	0	0.2	3	0.0	0
Breaking Dawn	yes	0.2	2	0.1	2	0.0	0	0.3	4	0.2	3
Men In Black	no	0.8	7	0.3	4	0.3	6	0.5	6	0.3	4
The Five-Year Engagement	yes	0.4	3	0.4	6	0.2	4	0.1	1	0.5	6
The Lucky One	yes	0.1	1	0.1	2	0.1	3	0.2	2	0.4	5
Bullet to the Head	yes	0.4	3	0.1	1	0.0	1	0.5	6	0.2	2
Movie	no	0.0	0	0.0	0	0.2	2	0.1	4	0.2	3
Titanic 3D	no	0.0	6	0.1	2	0.0	0	0.1	3	0.7	9
Act of Valor	no	0.0	0	0.0	0	0.4	4	0.1	2	0.2	4
Chronicle	yes	0.2	4	0.0	0	0.0	0	0.2	7	0.0	0
Star Wars	yes	0.4	3	0.4	6	0.7	7	0.1	4	0.1	1
The Mysterious Island	no	0.9	8	0.1	1	0.0	0	0.1	5	0.1	1
Man on a Ledge	no	0.1	1	0.6	9	0.6	6	0.0	0	0.1	1
Haywire	yes	0.1	1	0.3	4	0.4	4	0.0	0	0.0	0
The	yes	0.6	5	0.1	2	0.3	3	0.0	1	0.0	0
The Vow	yes	0.7	6	0.2	3	0.2	2	0.2	6	0.2	4
Dr. Seuss	no	0.4	3	0.1	1	0.0	0	0.1	3	0.4	6
Project X	yes	0.2	2	0.0	0	0.7	7	0.1	4	0.1	1
Vampire	no	0.5	4	0.3	4	0.9	9	0.2	6	0.1	2
7500	yes	0.2	2	0.5	7	0.5	5	0.1	2	0.4	6
Sky	no	0.6	5	0.4	6	0.0	0	0.0	1	0.2	3
Gravity	no	0.4	3	0.1	1	0.1	1	0.0	0	0.2	4
Titanic	no	0.5	4	0.1	1	0.1	1	0.0	0	0.1	2
750	no	0.7	6	0.1	2	0.6	6	0.1	3	0.1	1

Table 1: Latency and Hop Count : 20 Nodes

The time required and the hop count for each query is noted and shown in the table. The query search is carried out in 5 different nodes.

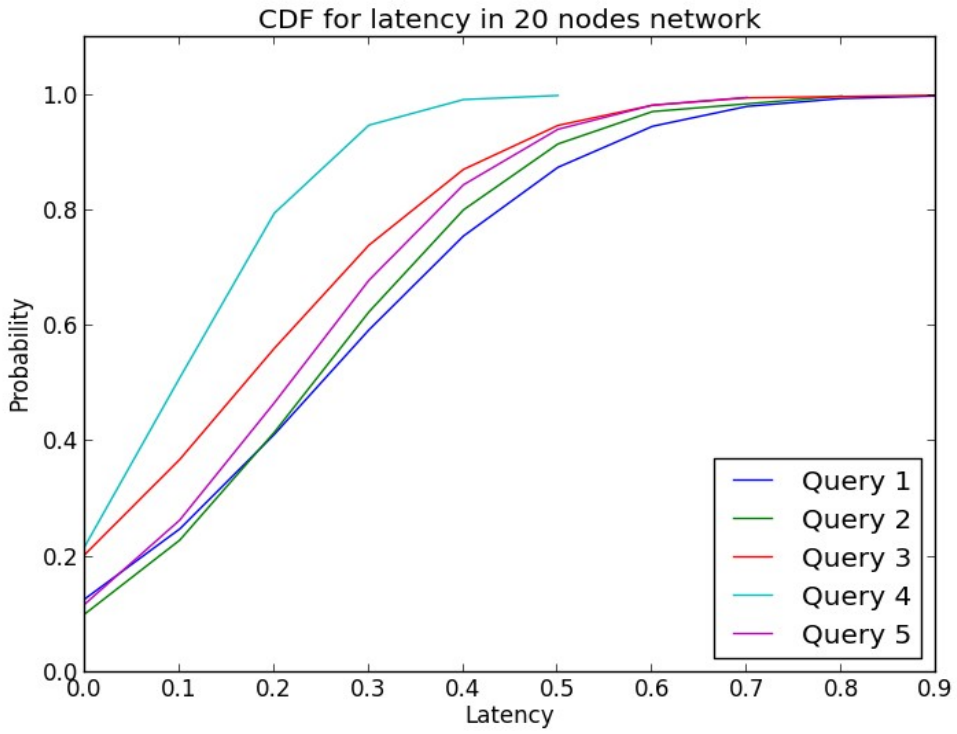
1.2 Number of Messages

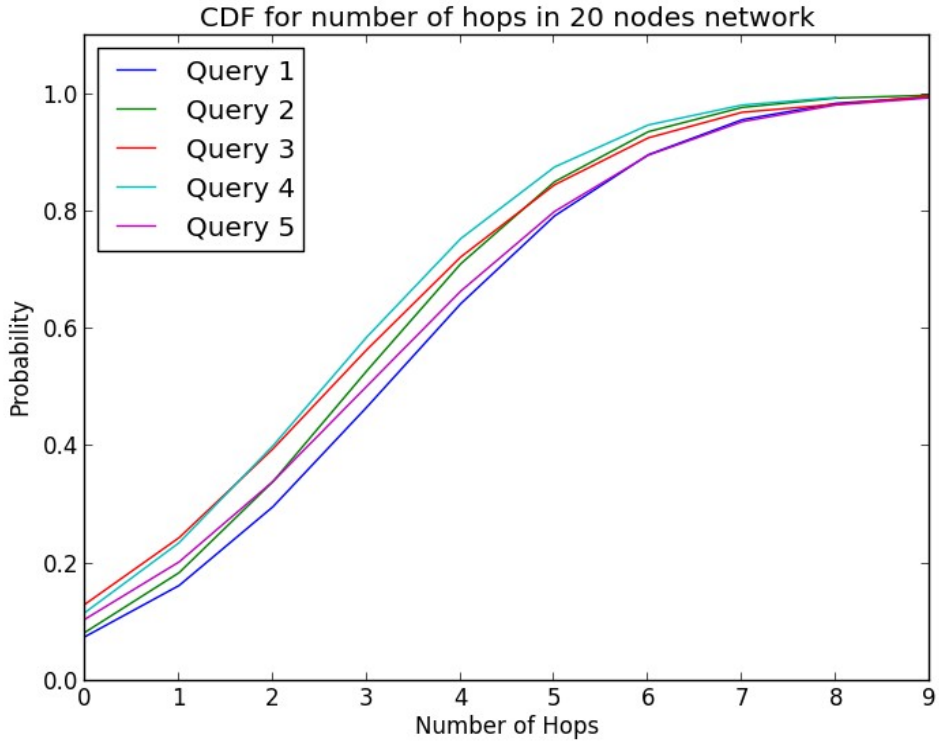
The number of messages handled by each PlanetLab node is shown in the following table:-

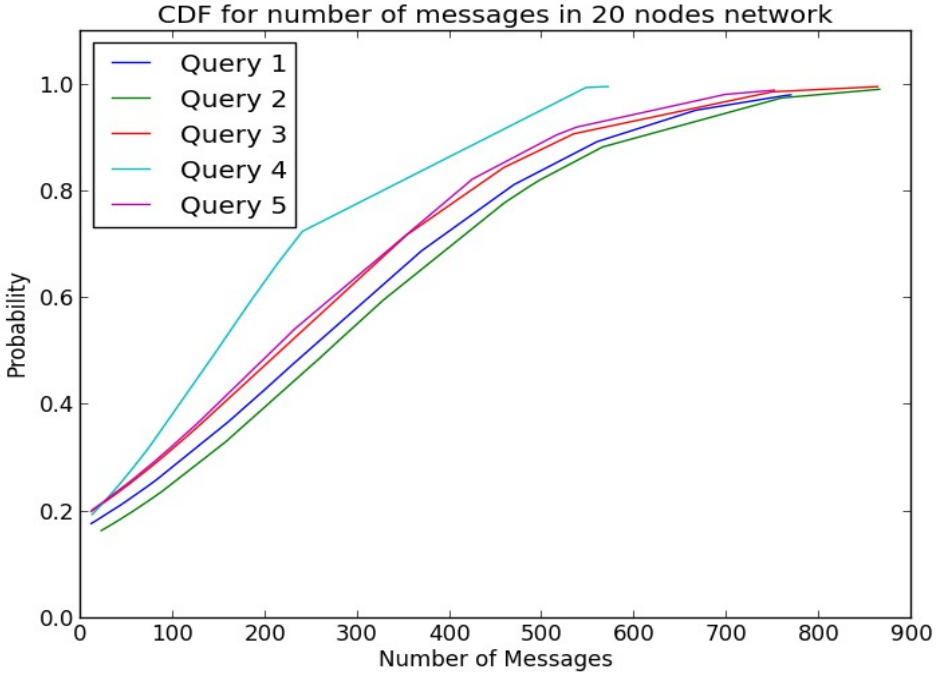
Node Number	Number of Messages				
	Search 1	Search 2	Search 3	Search 4	Search 5
1	42	56	135	547	221
2	82	258	458	185	52
3	16	459	86	76	424
4	369	157	75	240	87
5	45	497	11	18	78
6	769	22	749	184	231
7	198	759	132	68	54
8	72	42	54	57	15
9	11	327	863	148	537
10	79	33	125	55	515
11	43	486	45	42	57
12	228	279	72	18	751
13	469	156	15	27	13
14	72	565	136	571	698
15	196	85	353	165	131
16	763	35	115	212	12
17	666	865	127	75	96
18	159	75	26	13	13
19	559	88	155	12	123
20	49	79	534	214	21

Table 2: Number of Messages : 20 Nodes

The CDF for the above values are as shown below:-




CDF for number of hops in 20 nodes network
Query 1
Query 2
Query 3
Query 4
Query 5
Probability
Number of Hops
0.0
0.2
0.4
0.6
0.8
1.0
0
1
2
3
4
5
6
7
8
9


CDF for number of messages in 20 nodes network
Query 1
Query 2
Query 3
Query 4
Query 5
Probability
Number of Messages
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
600
700
800
900

1.3 Results

Maximum Latency : 0.94 sec
Minumum Latency : 0 sec
Average Latency : 0.1957 sec
Standard Deviation of Latency : 0.19408 sec

Maximum Hop Count : 9 hops
Minimum Hop Count : 0 hops
Average Hop Count : 2.83 hops
Standard Deviation of Hops : 2.255 hops
Per Query Cost = Number of hops per query = 2.83

Per Node Cost = Number of Messages per Node = 215.32

2 For Network Scale : 40 Nodes

2.1 Search Results

40 PlanetLab nodes are set up and they share their file details. A search request is issued from a text file and the following results are obtained:-

Query Request	Found	Search 1		Search 2		Search 3		Search 4		Search 5	
		Latency 1	Hop 1	Latency 2	Hop 2	Latency 3	Hop 3	Latency 4	Hop4	Latency 5	Hop 5
Twilight	yes	0.0	1	0.1	6	0.3	5	0.1	8	0.2	4
Jack	yes	0.2	5	0.1	4	0.5	9	0.0	0	0.1	2
American Idol	yes	0.3	6	0.1	8	0.1	1	0.1	5	0.5	8
Happy Feet	no	0.1	2	0.0	2	0.2	4	0.1	4	0.1	2
Twilight saga	no	0.2	4	0.0	0	0.3	6	0.2	9	0.0	0
Happy Feet	no	0.1	2	0.0	2	0.2	4	0.1	4	0.1	2
Happy Feet	no	0.1	2	0.0	2	0.2	4	0.1	4	0.1	2
Feet	no	0.0	1	0.0	3	0.5	9	0.1	6	0.2	3
Happy Feet	no	0.1	2	0.0	2	0.2	4	0.1	4	0.1	2
Twilight	yes	0.0	1	0.1	6	0.3	5	0.1	8	0.2	4
Windows	yes	0.0	0	0.1	9	0.5	8	0.2	9	0.1	2
Happy Feet	no	0.1	2	0.0	2	0.2	4	0.1	4	0.1	2
Mission Impossible	no	0.0	0	0.2	11	0.3	6	0.1	4	0.1	2
Twilight	yes	0.0	1	0.1	6	0.3	5	0.1	8	0.2	4
Windows 8	yes	1.4	2	0.0	1	0.0	1	0.5	11	0.4	6
The	yes	0.2	6	0.0	0	0.2	5	0.1	3	0.0	0
Happy	no	0.1	1	0.0	2	0.3	6	0.2	4	0.1	2
Windows 8	no	0.0	0	0.1	5	0.1	2	0.1	2	0.7	9
Happy Feet	no	0.1	2	0.0	2	0.2	4	0.1	4	0.1	2
Super Mario	yes	0.0	0	0.1	4	0.4	8	0.0	0	0.5	6
Jack and Jill	yes	0.3	4	0.1	6	0.2	5	0.1	2	0.9	12
Happy Feet	no	0.1	2	0.0	2	0.2	4	0.1	4	0.1	2
Impossible	no	0.1	1	0.0	1	0.2	4	0.3	6	0.3	4
Happy Feet	no	0.1	2	0.0	2	0.2	4	0.1	4	0.1	2
Turn Up The Music	yes	0.2	3	0.3	6	0.3	6	0.0	1	0.5	6
Adventures of Tintin	no	0.3	4	0.0	1	0.2	5	0.3	6	0.2	2
Twilight saga	no	0.2	4	0.0	0	0.3	6	0.2	9	0.0	0
Happy Feet	no	0.4	9	0.5	3	0.5	9	0.0	2	0.0	0
Super Mario	yes	0.1	1	0.0	1	0.3	7	0.0	0	0.0	0
American Pickers	yes	0.4	6	0.4	8	0.5	12	0.1	1	0.6	7
Microsoft Office 2010	no	0.1	1	0.3	4	0.1	3	0.0	0	0.5	6
The Silver Linings Playbook	yes	0.6	8	0.6	9	0.4	8	0.2	2	0.6	8
Breaking Dawn	yes	0.0	0	0.1	2	0.0	1	0.5	6	0.1	1
Gangster Squad	yes	0.1	1	0.1	1	0.0	0	0.4	5	0.5	6
Ted	yes	0.4	6	0.4	6	0.0	0	0.0	0	0.2	3
Magic Mike	yes	0.0	0	0.5	7	0.2	5	0.5	7	0.3	4
Abraham Lincoln: Vampire Hunter	no	0.7	6	0.2	3	0.1	3	0.2	3	0.0	0
Breaking Dawn	yes	0.0	0	0.1	2	0.0	1	0.5	6	0.1	1
Men In Black	no	0.4	3	0.0	0	0.3	6	0.6	8	0.3	4
The Five-Year Engagement	yes	0.5	4	0.0	0	0.2	4	0.1	1	0.5	6
The Lucky One	yes	0.1	1	0.3	4	0.1	3	0.0	0	0.4	5
Bullet to the Head	yes	0.2	2	0.4	6	0.0	1	0.4	5	0.2	2
Movie	no	0.0	0	0.1	2	0.2	2	0.2	6	0.2	3
Titanic 3D	yes	0.0	9	0.6	8	0.0	0	0.0	1	0.7	9
Act of Valor	yes	0.0	4	0.0	0	0.4	4	0.2	7	0.2	4
Chronicle	yes	0.2	8	0.0	0	0.4	4	0.1	3	0.2	4
Star Wars	no	0.4	3	0.4	6	0.8	8	0.1	5	0.5	9
The Mysterious Island	no	0.2	2	0.1	1	0.7	7	0.2	6	0.1	1
Man on a Ledge	yes	0.9	8	0.6	9	0.3	3	0.1	2	0.1	2
Haywire	no	1.1	9	0.3	4	0.9	9	0.2	7	0.2	4
The	yes	0.2	6	0.0	0	0.2	5	0.1	3	0.0	0
The Vow	yes	0.9	8	0.6	8	0.2	2	0.3	9	0.1	2
Dr. Seuss	no	0.7	6	0.0	0	0.0	0	0.1	2	0.0	0
Project X	no	0.4	3	0.0	0	0.7	7	0.1	3	0.0	0
Vampire	yes	1.2	10	0.1	1	0.9	9	0.1	4	0.2	4
7500	yes	0.5	4	0.5	7	0.4	4	0.2	6	0.5	9
Sky	no	0.6	5	0.1	2	0.2	2	0.1	2	0.0	0
Gravity	no	0.4	3	0.3	5	0.8	8	0.1	5	0.2	4
Titanic	yes	0.9	8	0.6	9	0.3	3	0.1	3	0.1	2
750	no	0.2	2	0.1	2	0.6	6	0.0	1	0.1	1

Table 3: Latency and Hop Count : 40 Nodes

The time required and the hop count for each query is noted and shown in the table. The query search is carried out in 5 different nodes.

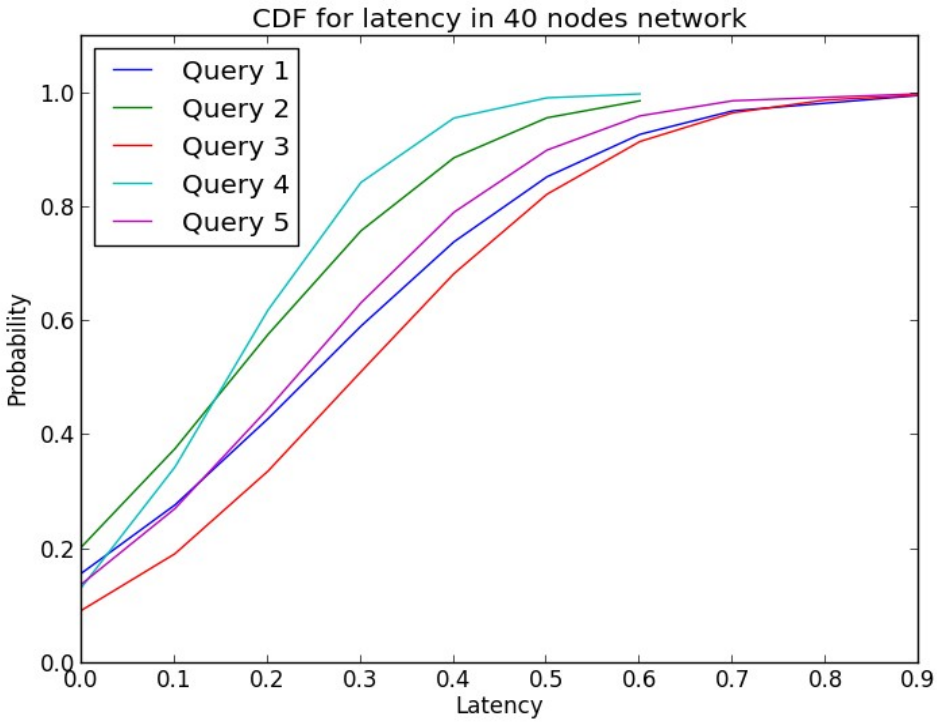
2.2 Number of Messages

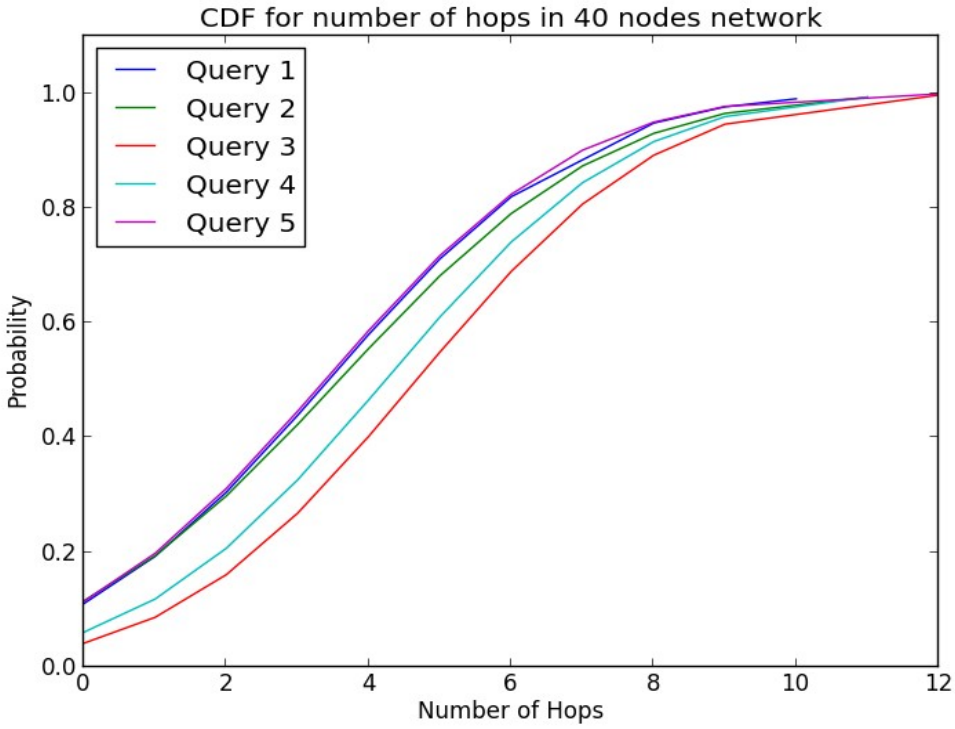
The number of messages handled by each PlanetLab node is shown in the following table:-

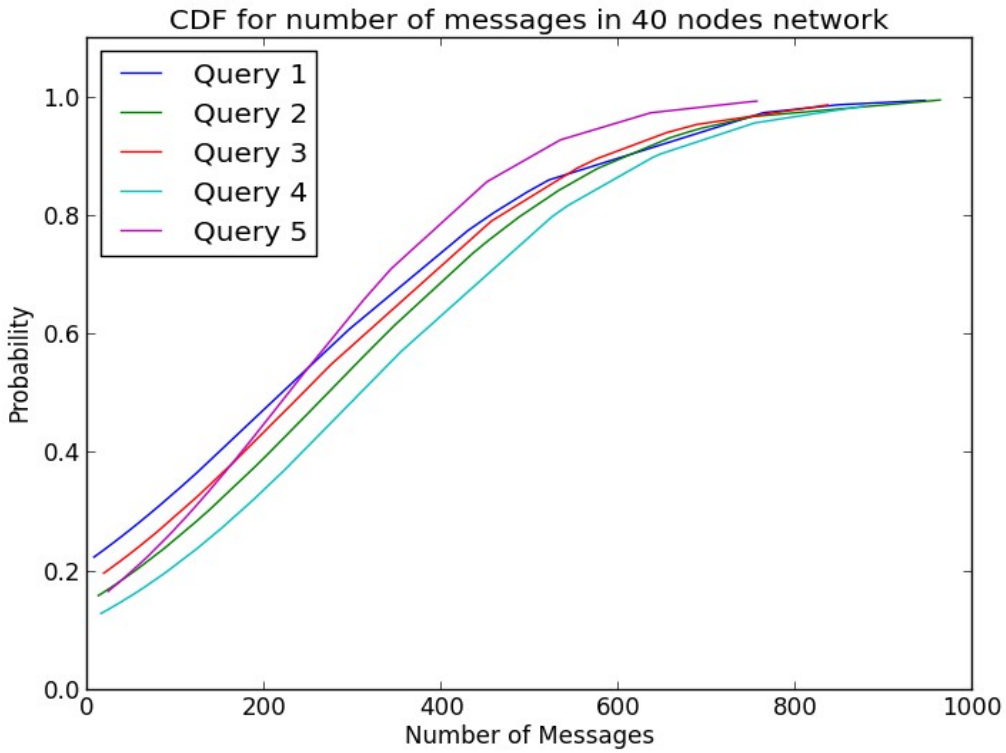
Node Number	Number of Messages				
	Search 1	Search 2	Search 3	Search 4	Search 5
1	23	435	54	64	534
2	48	245	687	52	123
3	106	34	18	542	68
4	429	48	574	537	24
5	55	204	45	638	213
6	73	345	123	185	185
7	16	12	654	54	154
8	48	657	274	542	243
9	763	486	55	524	112
10	852	45	688	189	44
11	44	138	19	753	184
12	239	86	575	123	67
13	12	24	46	34	137
14	33	678	124	647	165
15	49	21	655	65	752
16	25	189	275	53	23
17	29	15	56	543	97
18	433	57	689	538	342
19	19	453	20	639	245
20	846	57	576	186	89
21	496	15	456	55	451
22	123	576	553	543	168
23	7	532	24	525	159
24	459	963	165	190	534
25	23	752	57	754	23
26	82	123	22	54	756
27	36	52	24	87	167
28	50	312	78	88	123
29	48	32	836	542	312
30	766	693	54	36	65
31	295	436	25	189	216
32	59	246	166	876	35
33	432	35	58	223	26
34	23	49	23	151	636
35	49	205	25	354	753
36	10	346	35.1	21	24
37	78	13	234	53	98
38	69	658	22	533	343
39	521	487	54	86	246
40	946	46	554	15	90

Table 4: Number of Messages : 40 Nodes

The CDF for the above values are as shown below:-







2.3 Results

Maximum Latency : 0.9468 secs
Minimum Latency : 0 sec
Average Latency : 0.2216 sec
Standard Deviation of Latency : 0.2126 sec

Maximum Hop Count : 12 hops
Minimum Hop Count : 0 hops
Average Hop Count : 4.25 hops
Standard Deviation of Hops : 4.521 hops
Per Query Cost = Number of hops per query = 4.25

Per Node Cost = Number of Messages per Node = 252.47

3 Conclusion

The network scaling does not affect the latency but we can see that in case of 40 node network, the hops required for search are higher than that for the 20 node network. Also the number of messages handled by each node is higher in 40 node network. Compared to Lab 4 results, all search requests took a maximum of 3 hop counts in our design in Lab4. However the search requests were answered 100% in both labs provided the file is present in the network.