

Motivation – A user needs the internet to be stable to ensure that he has a good experience.

Internet is used for everything nowadays, from basic functionalities such as surfing, information collection to complicated functionalities such as file transfer, streaming and much more. If the internet is not stable, we cannot assure that our data is safely transmitted over a network. If there is an outage, it might be difficult to recover it and our data will be lost. The best example of instability is when streaming online. If the internet is unstable, we cannot view the video to the best of the quality available.

Methodology – Firstly, I fired up PING and TRACEROUTE to the nodes at PlanetLab. After a considerable amount of effort, 20 nodes were shortlisted based on the response I got. Then on these 20 nodes, I used ‘ssh’ to enter into a particular node. Out of 20, only 12 were accessible. So, I used a combination of these 12 nodes for collecting the data. I created 3 groups of 4 nodes. Each group was a combination of a node from USA East Coast, USA West Coast and either Trans-Atlantic or Trans-Pacific link. Every node in the group is connected to every other node in the group. For data collection, I developed a shell script on every node that ran periodically. On the collected data, I moved all the files in the local machine using WinSCP. Lastly, I used ‘gawk’ and ‘awk’ commands to sort through the data and perform analysis.

Analysis –

1. The following table illustrates the results obtained:

Node	Min (ms)	Avg (ms)	Max (ms)	Standard Deviation (ms)
planetlab-1.sjtu.edu.cn	264.929	317.878	344.987	18.996
pl1.rcc.uottawa.ca	48.185	55.312	63.616	4.636
planetlab2.cs.purdue.edu	48.346	53.729	60.873	3.333
planetlab3.cs.uoregon.edu	83.452	83.544	83.830	0.319
planetlab2.ie.cuhk.edu.hk	216.220	216.300	216.384	0.625
planetlab3.rutgers.edu	216.219	216.274	216.354	0.296
planetlab-2.calpoly-netlab.ne	192.203	192.460	192.750	0.511
plab1.cs.msu.ru	300.215	300.365	300.605	0.763
planetlab1.ie.cuhk.edu.hk	223.758	223.940	224.080	0.080
planetlab5.eecs.umich.edu	223.747	223.933	224.225	0.608
planetlab01.cs.washington.edu	165.719	165.855	165.959	0.564
planetlab-n1.wand.net.nz	320.087	320.357	321.695	0.785

2. There were many temporary outages but no permanent outage as shown in the following table:

Node	Temporary	Permanent
planetlab-1.sjtu.edu.cn	7290	0
pl1.rcc.uottawa.ca	11090	0
planetlab2.cs.purdue.edu	11081	0
planetlab3.cs.uoregon.edu	10210	0
planetlab2.ie.cuhk.edu.hk	7524	0

planetlab3.rutgers.edu	7350	0
planetlab-2.calpoly-netlab.ne	5029	0
plab1.cs.msu.ru	8514	0
planetlab1.ie.cuhk.edu.hk	4298	0
planetlab5.eecs.umich.edu	5835	0
planetlab01.cs.washington.edu	5820	0
planetlab-nl.wand.net.nz	6206	0

3. The core failure percentage is 1.52 and edge failure percentage is 98.48.
4. The reliability of continental links (e.g. US<->US, US<->Canada) is more than that of inter-continental links crossing the Atlantic or the Pacific Ocean. The traceroute command for inter-continental link takes more time than continental links.
5. No, I did not detect any route fluttering.

6. Considering the following routes:

Link	Hop count
planetlab-1.sjtu.edu.cn to pl1.rcc.uottawa.ca	Hop count = 24
planetlab-1.sjtu.edu.cn to planetlab2.cs.purdue.edu	Hop count = 24
pl1.rcc.uottawa.ca to planetlab-1.sjtu.edu.cn	Hop count = 23
planetlab2.cs.purdue.edu to planetlab-1.sjtu.edu.cn	Hop count = 20

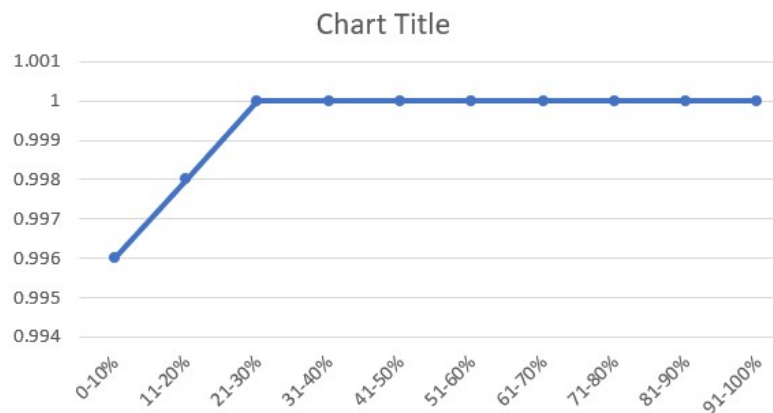
As we can see, the hop count changes from as soon as the sender becomes destination.

7. There was no triangular routing.

## 8. Table and their corresponding graphs for packet loss:

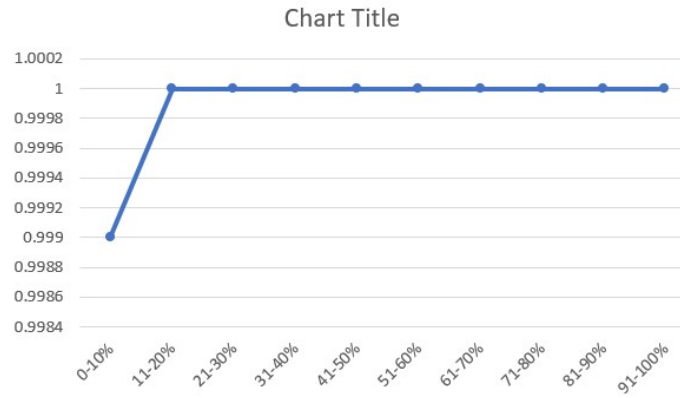
Packet loss for Node 1 (planetlab-1.sjtu.edu.cn):

Range	Histogram	PDF	CDF
0-10%	1304	$1304/1308 = 0.996$	0.996
11-20%	3	$3/1308 = 0.002$	0.998
21-30%	1	$1/1308 = 0.0007$	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1



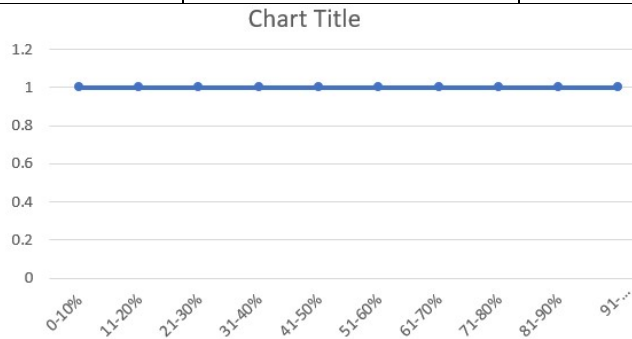
Packet loss for Node 2 (pll.rcc.uottawa.ca):

Range	Histogram	PDF	CDF
0-10%	1121	$1121/1122 = 0.999$	0.999
11-20%	1	$1/1122 = 0.0008$	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1



Packet loss for Node 3 (planetlab2.cs.purdue.edu):

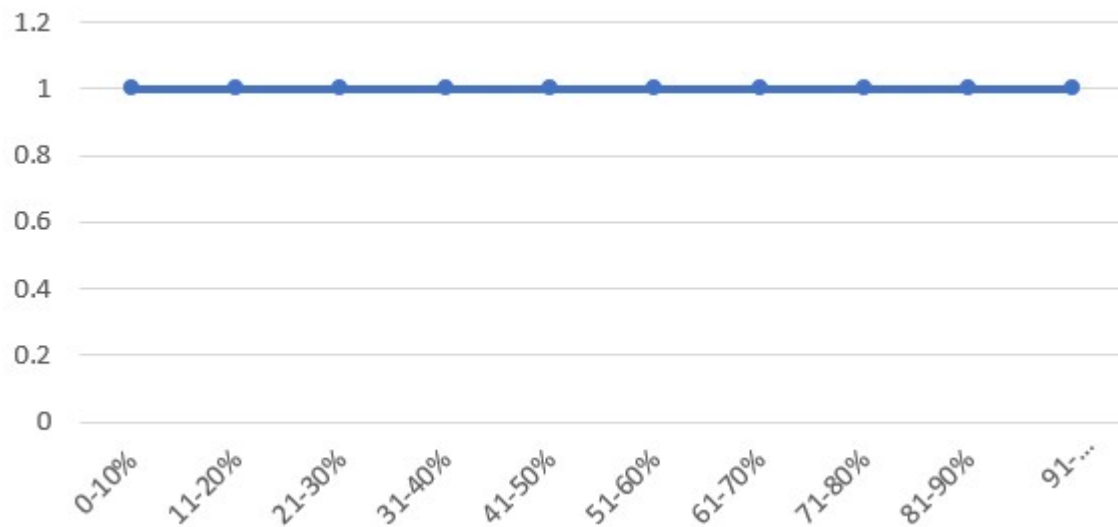
Range	Histogram	PDF	CDF
0-10%	1155	$1155/1155 = 1$	1
11-20%	0	0	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1



Packet loss for Node 4 (planetlab3.cs.uoregon.edu):

Range	Histogram	PDF	CDF
0-10%	1161	$1161/1161 = 1$	1
11-20%	0	0	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1

Chart Title



Packet loss for Node 5 (planetlab2.ie.cuhk.edu.hk):

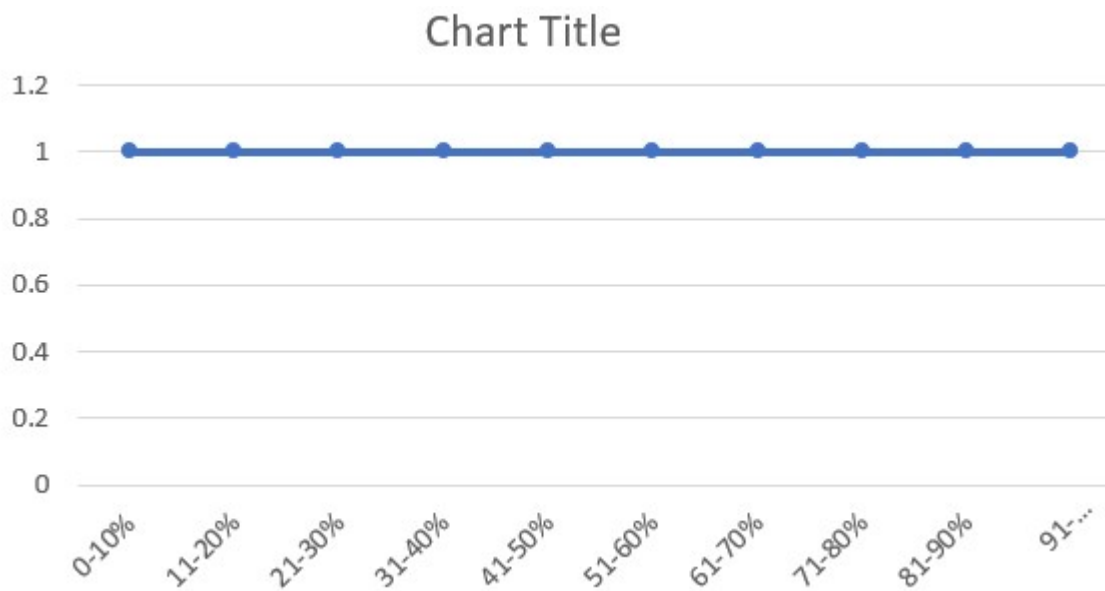
Range	Histogram	PDF	CDF
0-10%	1165	$1165/1167 = 0.998$	0.998
11-20%	0	0	0.998
21-30%	1	$1/1167 = 0.0008$	0.998
31-40%	0	0	0.998
41-50%	0	0	0.998
51-60%	1	$1/1167 = 0.0008$	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1

Chart Title



Packet loss for Node 6 (planetlab3.rutgers.edu):

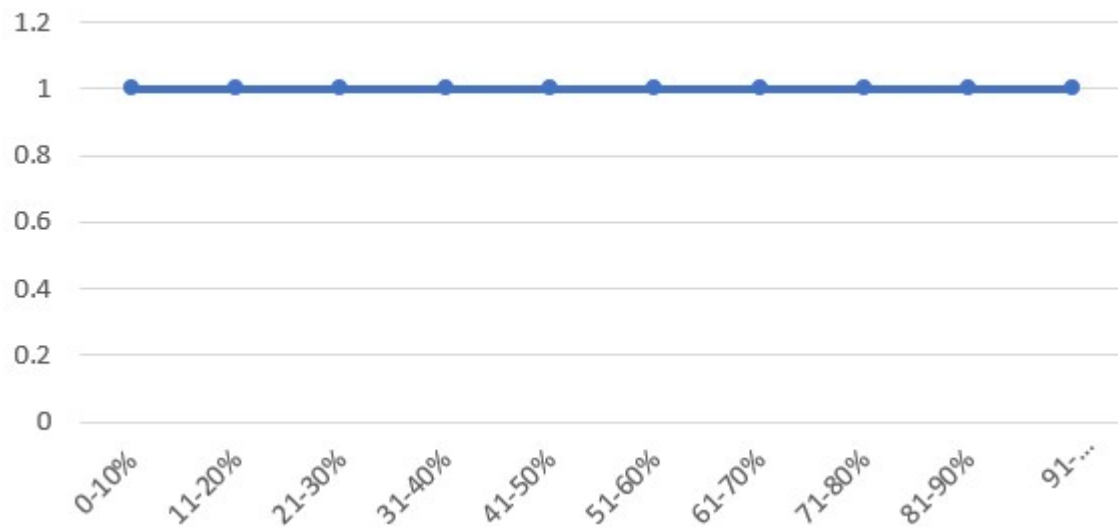
Range	Histogram	PDF	CDF
0-10%	1161	$1161/1161 = 1$	1
11-20%	0	0	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1



Packet loss for Node 7 (planetlab-2.calpoly-netlab.ne):

Range	Histogram	PDF	CDF
0-10%	1161	$1161/1161 = 1$	1
11-20%	0	0	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1

Chart Title

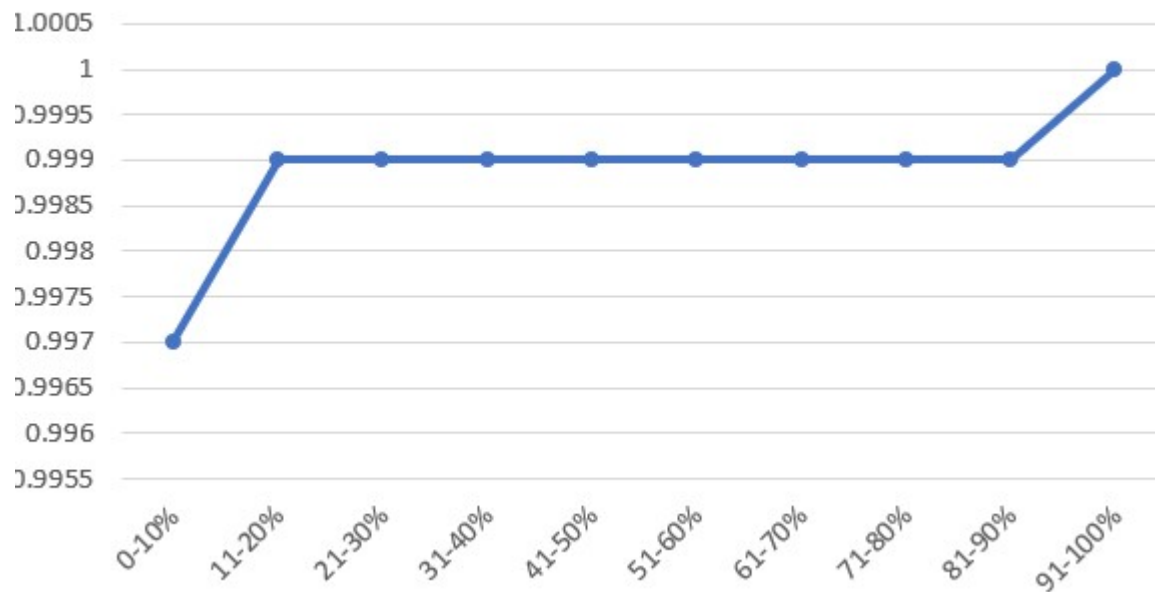


Packet loss for Node 8 (plab1.cs.msu.ru):

Range	Histogram	PDF	CDF
0-10%	1158	$1158/1161 = 0.997$	0.997
11-20%	2	$2/1161 = 0.0017$	0.999
21-30%	0	0	0.999
31-40%	0	0	0.999
41-50%	0	0	0.999
51-60%	0	0	0.999
61-70%	0	0	0.999
71-80%	0	0	0.999
81-90%	0	0	0.999
91-100%	1	$1/1161 = 0.0008$	1

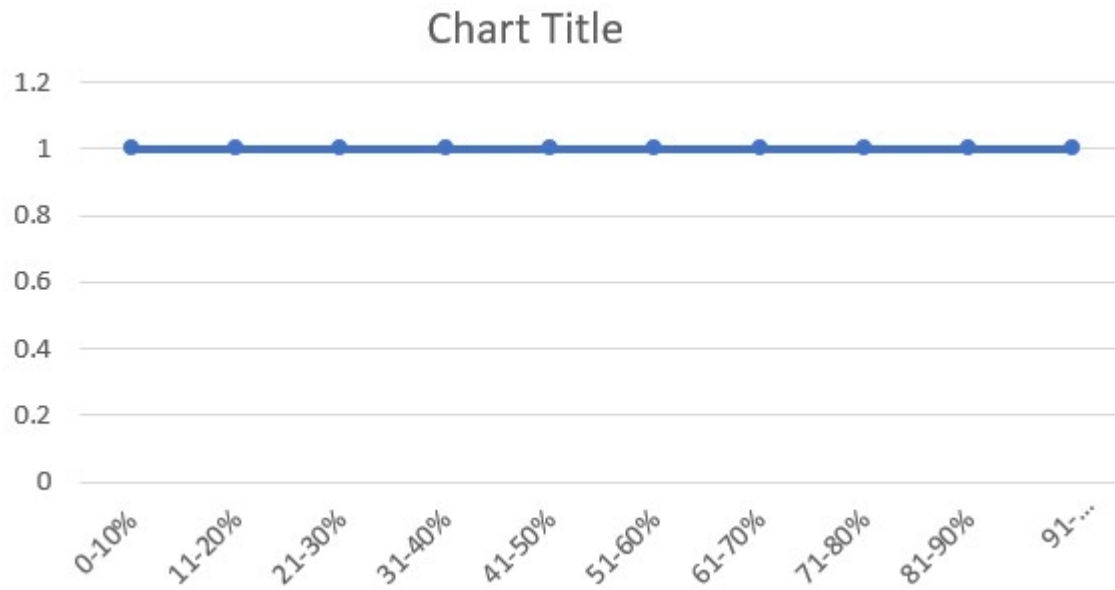


Chart Title



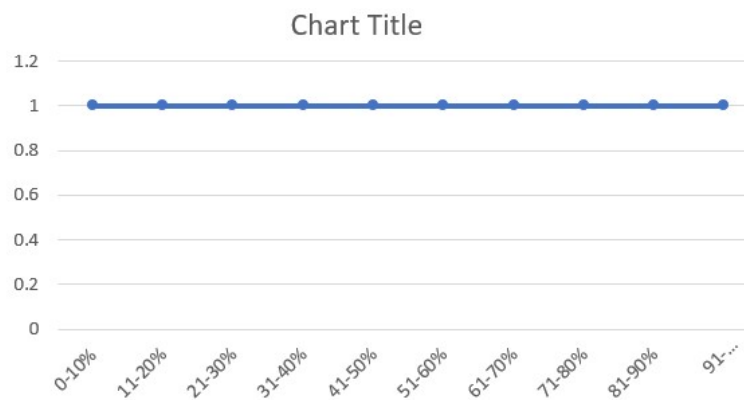
Packet loss for Node 9 (planetlab1.ie.cuhk.edu.hk):

Range	Histogram	PDF	CDF
0-10%	1166	$1166/1166 = 1$	1
11-20%	0	0	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1



Packet loss for Node 10 (planetlab5.eecs.umich.edu):

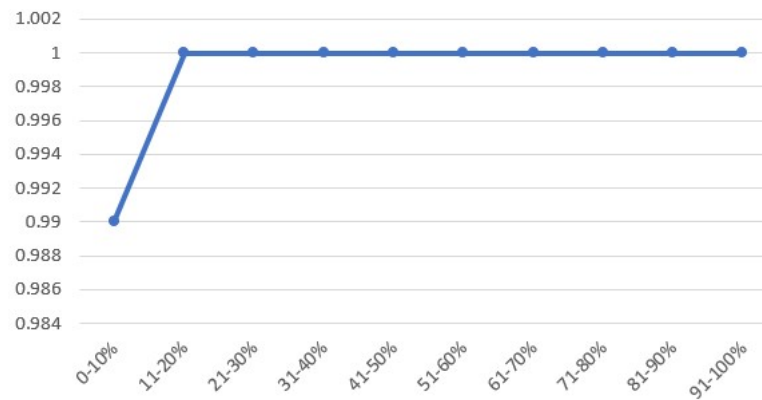
Range	Histogram	PDF	CDF
0-10%	1164	$1164/1164 = 1$	1
11-20%	0	0	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1



Packet loss for Node 11 (planetlab01.cs.washington.edu):

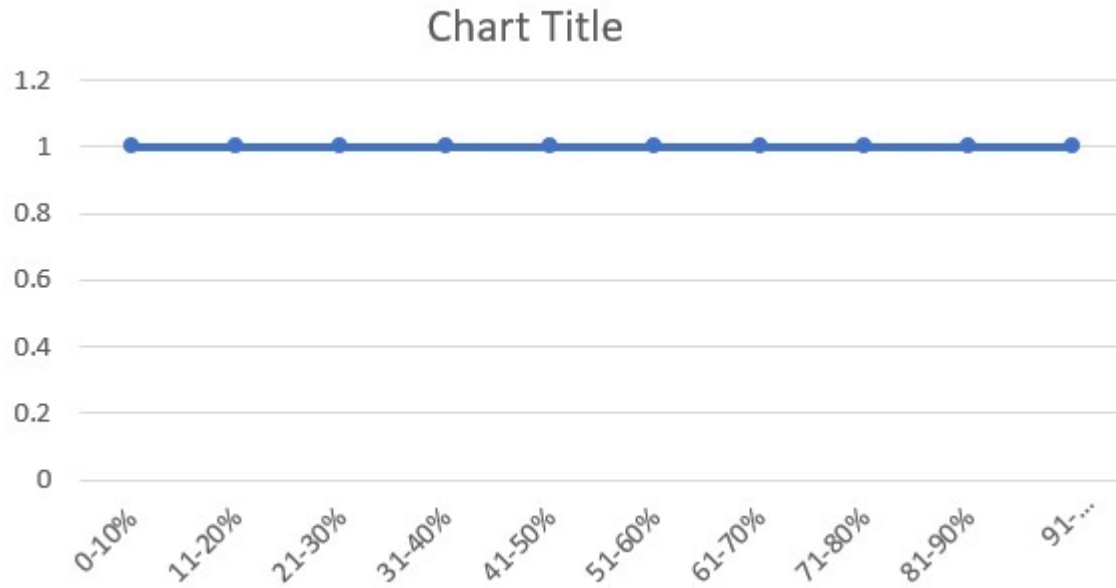
Range	Histogram	PDF	CDF
0-10%	1166	$1166/1167 = 0.99$	0.99
11-20%	1	$1/1167 = 0.0008$	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1

Chart Title



Packet loss for Node 12 (planetlab-n1.wand.net.nz):

Range	Histogram	PDF	CDF
0-10%	1161	$1161/1161 = 1$	1
11-20%	0	0	1
21-30%	0	0	1
31-40%	0	0	1
41-50%	0	0	1
51-60%	0	0	1
61-70%	0	0	1
71-80%	0	0	1
81-90%	0	0	1
91-100%	0	0	1



9. Based on the sample of measurements, I think that Internet routing instability is pretty much the same.

Conclusion – As we can see from the data that I collected, it is pretty clear that internet stability is very important and can be calculated and tracked along the time.