PingER VM Comparative analysis of significant statistical difference with non VM

Introduction

This is a study of the differences (if any) of the measurements from pinger.slac.stanford.edu (a single (bare hardware non-virtual) Linux host (Dell PowerEdge 2650) running the PingER Measurement Agent (MA) and pingervm (AKA dhcp-nebula-124-66.slac.stanford.edu a Nebula KVM Virtual Machine with floating addresses) MA measuring the ping Round Trip Times (RTTs) to hosts worldwide and between pinger and pingervm. Hencefiorth we refer to ping requests from pinger to pingervm as pinger to pingervm or pinger>pingervm and ping requests from pingervm to pinger as pinger to pingervm or pingervm>pinger. Both pinger and pingervm are located on the second floor of Building 50 (the computer center) at SLAC. The traceroutes between the two machines are seen here.

The measurements were made from February 26th 2015 and March 3rd 2015. Every ~30 minutes a burst of 10-30 (10 if no loss else up to 30 until 10 ping responses were received) ping requests was sent by the MA to the target. The ping packet size was 100Bytes, the ping requests in the burst were separated by 1 second. The number of pings between pinger and pingervm was ~6000.

Below we look at a statistical analysis of the results for pings from pinger and pingervm to the World, to N. America, Europe and between pinger and pingervm.

To World (excluding SLAC targets).

The following tables are from pingtable.pl

PingER non VM measurement agent

Tick	min	25th%	avg	median	75th%	90th%	95th%	max	iqr	std dev	# pairs
Mar2015	23.312	178.346	239.329	211.152	293.499	339.425	379.947	780.659	115.153	104.510	107
Feb2015	22.689	176.167	241.608	212.435	295.448	326.637	362.350	803.815	119.281	110.212	112

NB. February data is incomplete for the VM, so leave out

PingER VM measurement agent

Tick	min	25th%	avg	median	75th%	90th%	95th%	max	iqr	std dev	# pairs
Mar2015	23.698	176.221	238.352	213.278	294.279	340.938	381.412	796.140	118.058	109.834	107
Feb2015	22.515	178.790	239.368	210.327	301.033	329.510	369.066	807.798	122.243	110.401	110

To Europe

PingER non VM Measurement agent

Tick	min	25th%	avg	median	75th%	90th%	95th%	max	iqr	std dev	# pairs
Mar2015	150.996	162.944	175.858	173.632	186.939	201.843	204.698	204.698	23.995	17.131	14

PingER VM Measurement agent

To Europe

Tick	min	25th%	avg	median	75th%	90th%	95th%	max	iqr	std dev	# pairs
Mar2015	151.017	162.965	176.121	173.904	185.921	199.620	208.584	208.584	22.956	17.586	14

To N. America

PingER non VM measurement agent

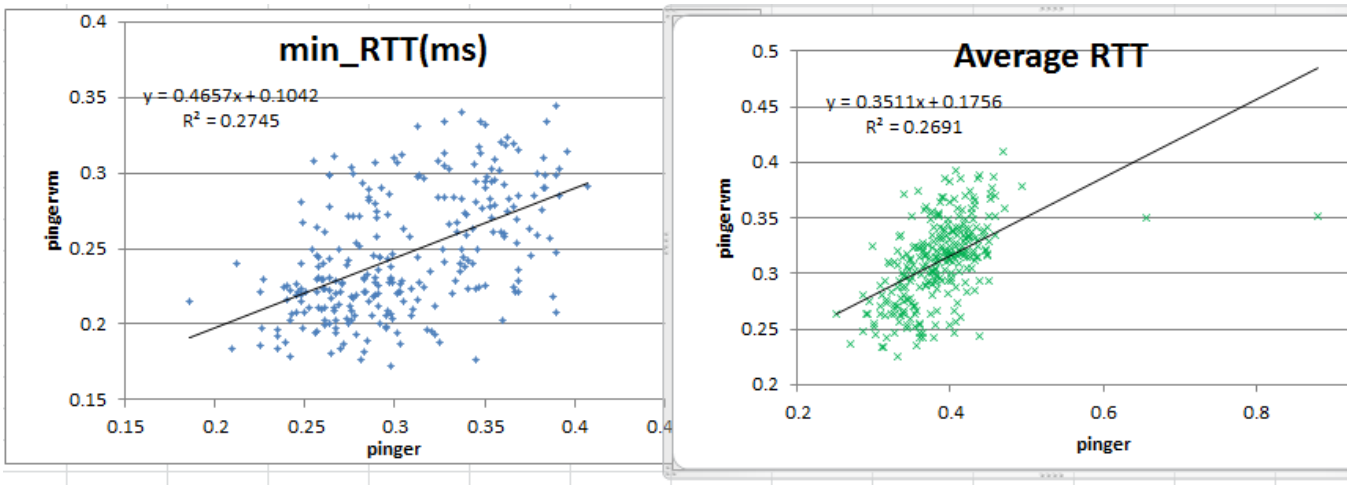
Tick	min	25th%	avg	median	75th%	90th%	95th%	max	iqr	std dev	# pairs
Mar2015	23.312	.	54.890	62.042	79.315	79.315	79.315	79.315	.	28.678	3

PingER VM measurement agent

Tick	min	25th%	avg	median	75th%	90th%	95th%	max	iqr	std dev	# pairs
Mar2015	23.095		41.357	42.888	62.077	79.350	79.350	79.350	61.775		4

Correlation plots of pinger vs pingervm for hourly measurements

Below are correlation plots of hourly PingER measurements between pinger.slac.stanford.edu and pingervm.slac.stanford.edu between Feb 26 and March 3rd, 2015.



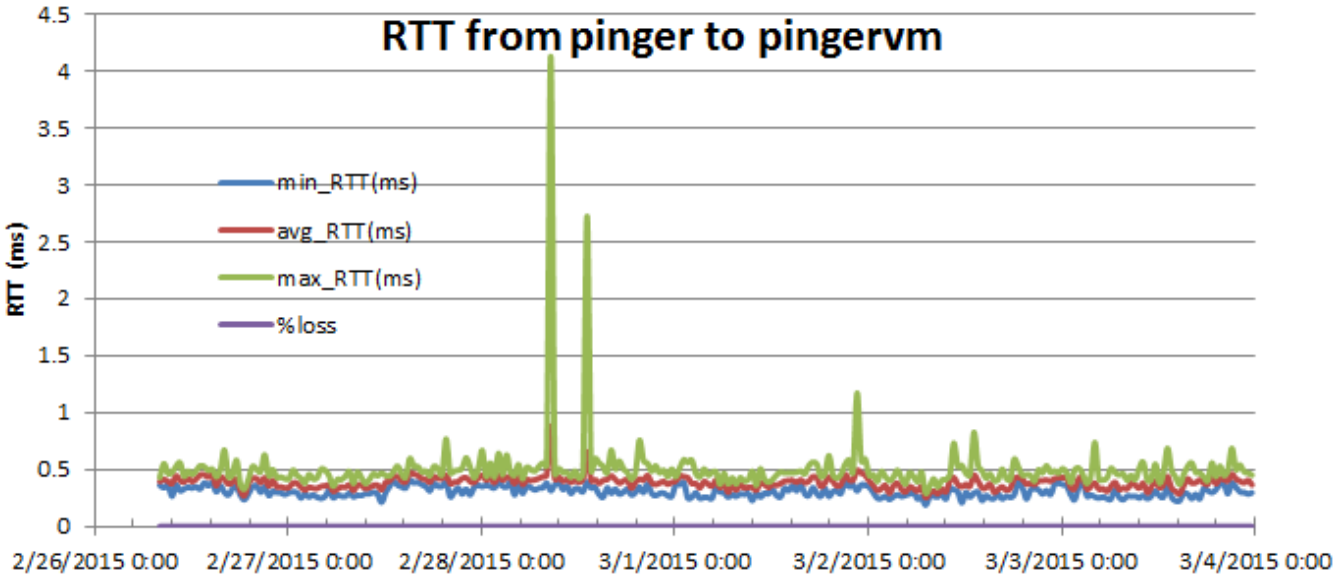
Time series

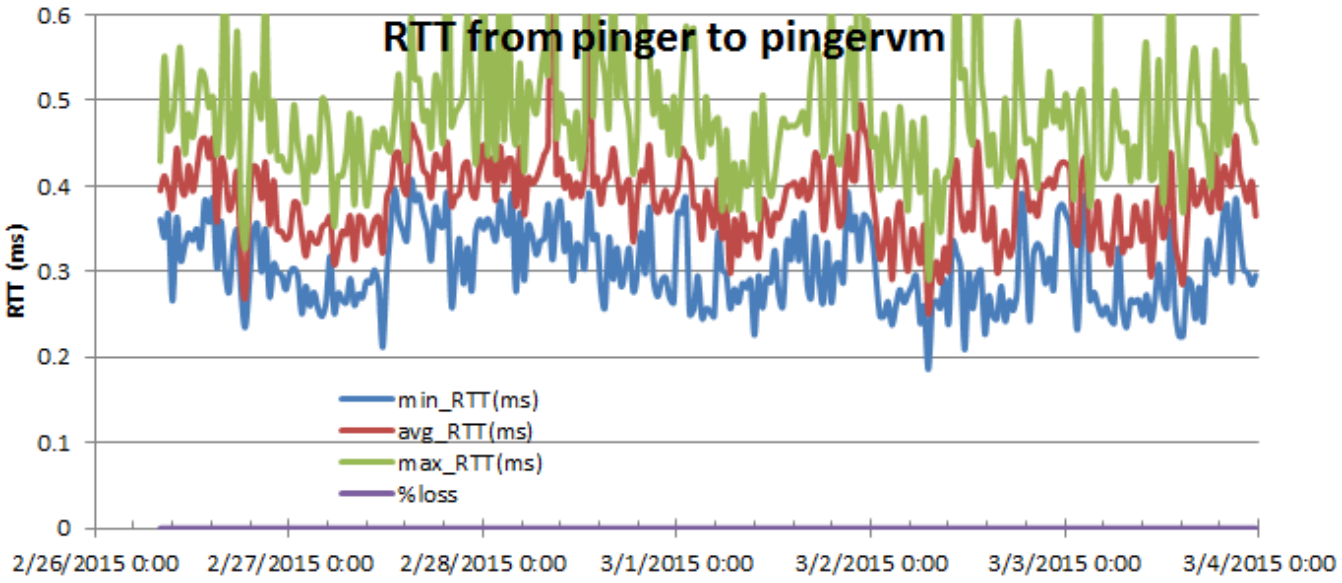
If one compares the average and median statistics for the tow sets of data, one gets the tables below:

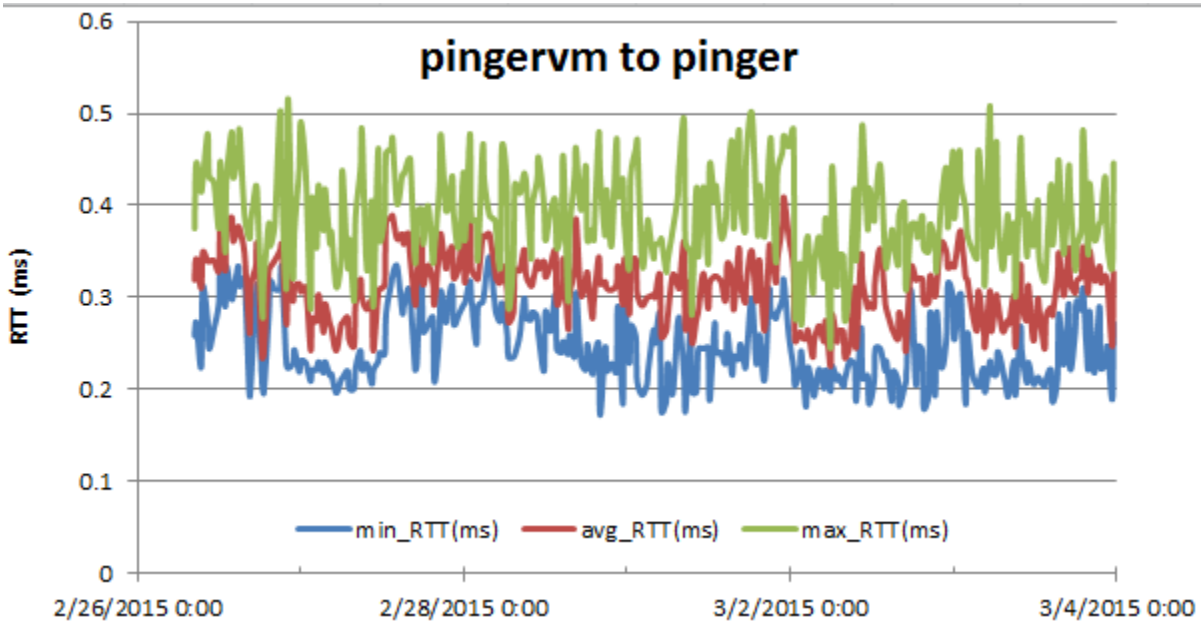
pinger>pingervm	min_RTT(ms)	avg_RTT(ms)	max_RTT(ms)
Average	0.304368	0.385107	0.50461
standard deviation	0.045313	0.054924	0.272844
median	0.297	0.385	0.471
IqR	0.07625	0.0635	0.08075
Count	272	272	272

pingervm>pinger	min_RTT(ms)	avg_RTT(ms)	max_RTT(ms)
Average	0.245923	0.310827	0.392096
stdev	0.040275	0.03718	0.052863
Median	0.237	0.315	0.386
IQR	0.06425	0.04925	0.077
Count	272	272	272

And plots of the time series appears as below (spreadsheet)


RTT from pinger to pingervm
RTT (ms)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
min_RTT(ms)
avg_RTT(ms)
max_RTT(ms)
%loss
2/26/2015 0:00
2/27/2015 0:00
2/28/2015 0:00
3/1/2015 0:00
3/2/2015 0:00
3/3/2015 0:00
3/4/2015 0:00


RTT from pinger to pingervm
RTT (ms)
0.6
0.5
0.4
0.3
0.2
0.1
0
min_RTT(ms)
avg_RTT(ms)
max_RTT(ms)
%loss
2/26/2015 0:00
2/27/2015 0:00
2/28/2015 0:00
3/1/2015 0:00
3/2/2015 0:00
3/3/2015 0:00
3/4/2015 0:00



Looking at the above manually scaled plots of pinger>pingervm and pingervm>pinger it is apparent the RTTs from pinger to pingervm are > pingervm to pinger. Looking at the average, standard deviation, median and IQR tables and the differences between pinger as the monitoring site and pingervm as the monitoring site, we see in tabular form (where the average errors are +- (stdev(pinger>pingervm)+stdev(pingervm>pinger)) and the median errors are +-(IQR(pinger>pingervm) + IQR(pingervm>pinger)). the Probabilities are those that the pinger>pingervm and pingervm>pinger distributions are the same (assuming normal distributions).

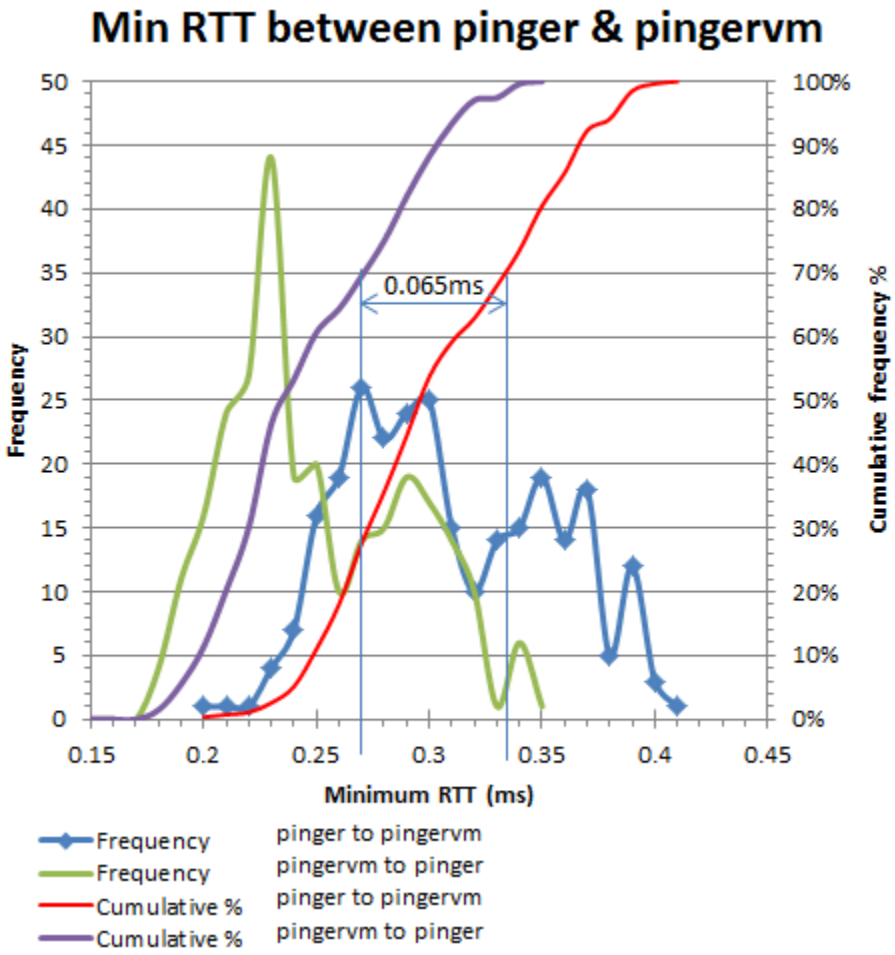
Diff (pinger-pingervm)	min_RTT(ms)	+-	Probability	avg_RTT(ms)	+-	Probability	max_RTT(ms)	+-	Probability
Average	0.058445	0.085588	0.682689	0.074279	0.092104	0.682689	0.112515	0.325707	-0.99405
stdev	0.005037			0.017744			0.21998		
median	0.06	0.1405		0.07	0.11275		0.085	0.15775	
IqR	0.012			0.01425			0.00375		

It appears that the min_rtts, avg_rtts and max_rtts are within 1 standard deviation (better than 68% assuming a normal distribution) of one another.

By looking at the cumulative distributions we can get the Median differences probability.

Minimum RTT distributions between pinger and pingervm

We focus on the minimum RTT since that is least affected by queuing etc.


Min RTT between pinger & pingervm
50
45
40
35
30
25
20
15
10
5
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.065ms
Frequency
Cumulative frequency %
0.15
0.2
0.25
0.3
0.35
0.4
0.45
Minimum RTT (ms)
Frequency
Frequency
Cumulative %
Cumulative %
pinger to pingervm
pingervm to pinger
pinger to pingervm
pingervm to pinger