PingER and Covid-19 and the Republic of South Africa and the impact of High Speed connectivity

The Republic. of South Africa detected its first novel coronavirus infection on 5 March. For the next few weeks, the epidemic followed an exponential curve similar to those in the United Kingdom, the United States, and many other countries. On 15 March, the country's president, Cyril Ramaphosa, declared a national state of emergency banning visitors from high-risk countries, stopping large gatherings, closing more than half of its land borders, and shutting schools. On 27 March the country started a 21-day lockdown, closing all borders and confining everyone except those performing essential services to their homes except to buy groceries and medicine or to collect welfare payments." Science Magazine.

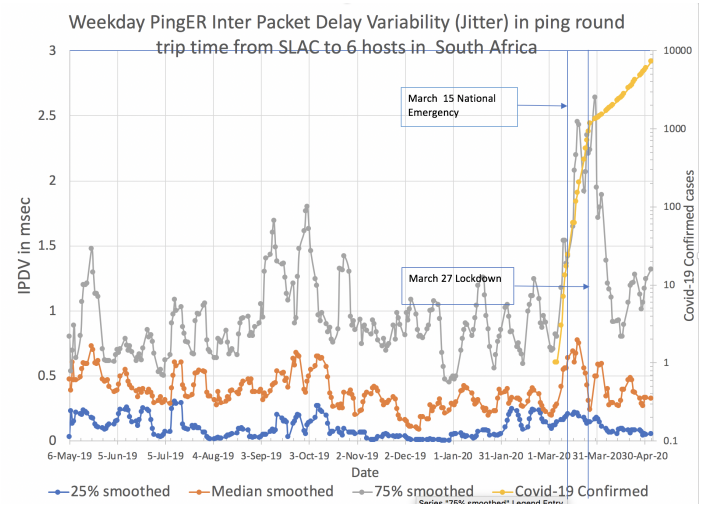
PingER

We investigated various PingER metrics derived from the ping measurements made from SLAC, including average Round Trip Time (RTT), Conditional Loss Probability (CLP). Inter Packet Delay Variability IPDV), Inter Quartile Range (IQR) of the round trip times, and derived throughput (see Tutorial on Internet Monitoring and Pinger at SLAC). The most sensitive to this type of disruption appeared to be IPDV.

We used the PingER IPDV daily data for the last 365 days. It includes measurements from the SLAC host pinger.slac.stanford.edu in Northern California (Lat, Long =37.4177, -122.2035) to 7 hosts in South Africa.

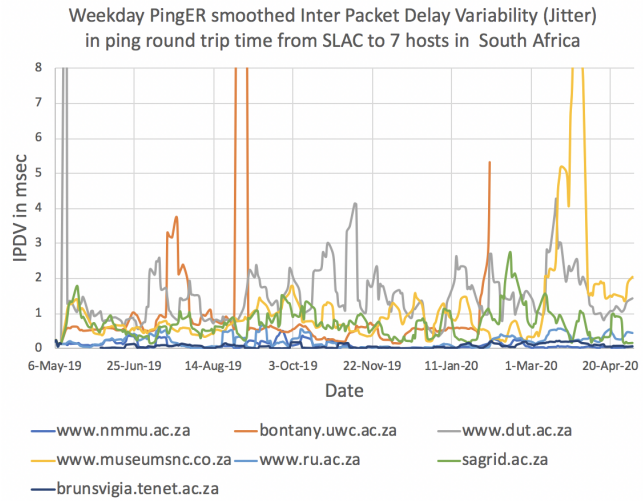
www.nmmu.ac.za, Port Elizabeth	bontany.uwc.ac.za, Cape Town	www.dut.ac.za, Durban	http://www.museumsnc.co.za./, Kimberley	www.ru.ac.za, Grahamstown	sagrid.ac.za,?	brunsvigia.tenet.ac.za, Cape Town

Since there are large differences between weekday and weekend performance responses, we selected just the weekday (determined by UDT) measurements and smoothed the data using a sliding average over the last 5 days. The chart below shows the result (the 25 percentile, median and 75 percentiles for the 7 hosts) together with South Africa's Covid-19 confirmed cases from Johns Hopkins University's GitHub site: https://github.com/CSSEGISandData/COVID-19, plus the dates of notable interventions taken by South Africa.



It is seen that the 75 percentile shows a notable increase at the time of the interventions

We then looked in more detail at the IPDVs for the individual hosts. See below.



It is seen that the major contributor to the rise in IPDV is www.museumsnc.co.za, followed by www.dut.ac.za. The bontany.uwc.ac.za is no longer accessible. The other hosts are connected to the South African Tertiary Education Network (TENET). That, in turn, connects directly to ESnet that connects SLAC to the Internet thus avoiding any commodity networks. ESnet supports the Energy Sciences in the US and is well provisioned. TENET supports tertiary academic and research establishments in South Africa. It is a well provisioned network that is probably lightly loaded on average, thus changes in traffic volumes (e.g. due to lockdown) have little effect.

Both www.museumsnc.co.za and www.dut.ac.za traverse commodity networks after leaving ESnet and are thus less likely to be over-provisioned and more sensitive to unplanned or increases in traffic load. For example, a traceroute for www.museumsnc.co.za leaves the ESnet network at Sunnyvale near SLAC to join the Equinix network, followed by the PCCW Inc. network, followed by Afrihost in South Africa.

Traceroute from SLAC to www.museumsnc.co.za from SLAC

```
Wed May  6 12:29:15 2020: executing exec(traceroute -m 30 -q 1 -w 1 -A 154.0.166.162 140)=traceroute
from 134.79.197.214(www.slac.stanford.edu) to  154.0.166.162(www.museumsnc.co.za) for 134.79.138.4
traceroute to 154.0.166.162 (154.0.166.162), 30 hops max, 140 byte packets
 1  rtr-serv01-02-serv01-dmz-webserv.slac.stanford.edu (134.79.197.131) [AS3671]  0.644 ms
 2  rtr-core1-p2p-serv01-01.slac.stanford.edu (134.79.253.249) [AS3671]  0.568 ms
 3  rtr-fwcore2-trust-p2p-core2.slac.stanford.edu (134.79.254.146) [AS3671]  1.114 ms
 4  rtr-core1-p2p-fwcore1-untrust.slac.stanford.edu (134.79.254.137) [AS3671]  1.346 ms
 5  rtr-border1-7k-p2p-core2.slac.stanford.edu (134.79.252.177) [AS3671]  1.523 ms
 6  rtr-border2-7k-p2p-border1-7k.slac.stanford.edu (192.68.191.214) [AS3671]  1.690 ms
 7  sunn-cr5-ip-p2p-border2-7k.slac.stanford.edu (192.68.191.233) [AS3671]  1.961 ms
 8  sacrcr5-ip-b-sunncr5.es.net (134.55.40.145) [AS293]  4.510 ms #AS = Equinix
 9  pnwgcr5-ip-a-sacrcr5.es.net (134.55.43.21) [AS293]  18.646 ms
10  ge3-0.cr02.sea01.pccwbtn.net (206.81.80.13) [*]  18.886 ms
11  HundredGE0-3-0-0.br02.frf06.pccwbtn.net (63.218.232.33) [AS3491]  162.286 ms #AS=PCCW Global,
Inc.
12  telkom.te0-1-0-15.br02.frf06.pccwbtn.net (63.218.233.102) [AS3491]  157.321 ms
13  *
14  *
15  169-1-21-100.ip.afrihost.co.za (169.1.21.100) [AS37611]  338.447 ms #AS=Afrihost (PTY) Ltd

16  gm-colo3-core2-lq.aserv.co.za (169.1.21.187) [AS37611]  317.722 ms
```

Countries bordering South Africa

A possibility explored was just selecting hosts in the 6 countries bordering and including South Africa (TLDs BW, LS, SZ, ZA, ZW) and then just using hosts with TLDs .co, .com, .go, .gov or including banc or bank in the name. The ideas was that such hosts are probably on commodity networks. However as of May 5th, 2020 these countries have few Covid-19 cases (BW:23, LS: 0, NA 101, SZ (Eswatine): 145, ZA: 218,329, ZW:34). As expected we could not identify a significant impact of Covid-19 on IPDV.

Useful other documents

Coronavirus-free Lesotho relaxes lockdown restrictions, 5/6/2020

Covid-19 9n Africa, from The Center For Disease Dynamics, Economics & Policy