

Measuring the Internet during Covid-19 to Evaluate Work-from-Home



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Introduction

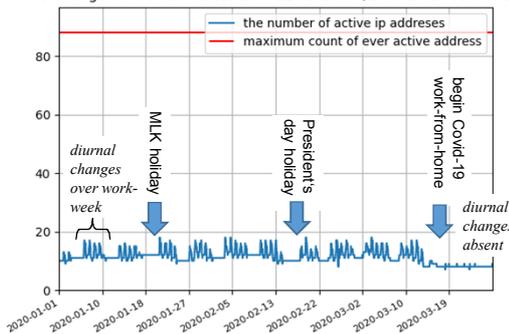
Covid-19 has prompted recommendations around the world to study and work-from-home. But how well are these recommendations carried out? And what happens in areas with less publicity? Our research goal is to observe Covid-19-triggered work-from-home. Work-from-home changes Internet use, with more IP addresses active at home and fewer at work. We detect these changes by observing the public, IPv4 Internet---we probe about 5M /24 IPv4 blocks (like 192.0.2.*) with ICMP echo request ("pings") every 11 minutes. While we cannot detect changes everywhere, due to firewalls and always-on-routers, we can monitor about 220k /24 IP blocks.

This post presents our [methodology](#), [early results](#), and where to get [more information](#).

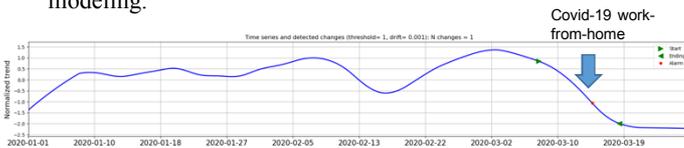
Methodology: Detecting Network Changes?

- ❖ **Reuse existing IPv4 probing** We reuse publicly available data from Trinocular outage detection, scanning IPv4 since 2013. Here we use datasets `internet_outage_adaptive_a39w-20200101` and `_a40w-20200401` covering about 5M /24 IPv4 address blocks in the first half of 2020. For data availability, see: <https://ant.isi.edu/datasets/>
- ❖ **Identify active addresses by accumulating partial scans** Trinocular probes each block every 11 minutes, but only a few addresses. We accumulate all addresses over time to evaluate status.
- ❖ **Identify change-sensitive blocks** Not all blocks are suitable for our analysis. We discard blocks that do not reflect a daily schedule, or where that change is too small to track reliably.

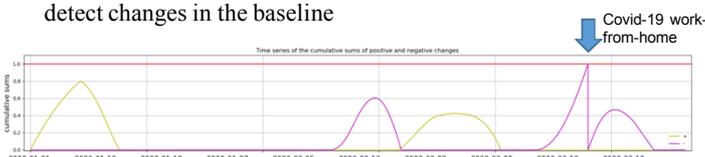
The change of active addresses in 128.9.144.0/24 over three months.



- ❖ **De-trend address usage** Before we can detect changes, we remove daily fluctuations by applying STL seasonal trend modeling.



- ❖ **Detect changes in usage** We apply the CUSUM algorithm to detect changes in the baseline



Early Results from 2020h1

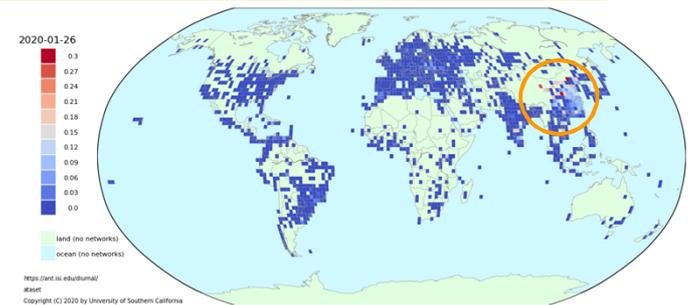
Global Coverage



Of the 5M /24 IPv4 blocks from Trinocular, about 220k are change-sensitive. We show them here as circles on a 2x2 degree latitude/longitude grid with circle area indicating number of networks. => we have global coverage, but it is best in China, Brazil and India.

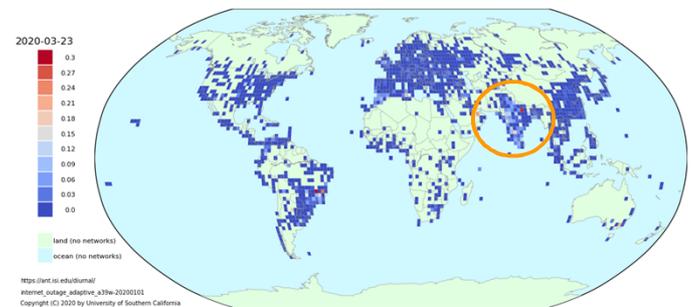
The results below are observations we discovered in these 220k blocks.

Evidence of Change in Wuhan, China, Jan. 26



- ❖ In this world map each 2x2 degree latitude/longitude square is shaded by the fraction of /24 blocks that change on this day.
- ❖ We see many changes in Chinese networks (about 15% of blocks in the circled area) on 2020-01-26, about the time Wuhan went into lockdown. => We have early results suggesting we detect Covid-triggered work-from-home

Evidence of Change in India, Mar. 23



We see some white squares in India on 2020-03-23, around the day curfew began here.

More Information

- ❖ Our new approach detects large network changes
- ❖ Network usage changes correlate with real-world Covid-19 activities.
- ❖ Watch at <https://ant.isi.edu/minceq/> for our tech report by 2021-01.
- ❖ Trinocular data is available at <https://ant.isi.edu/datasets/>.

Contact us if you are interested in data from our Covid analysis.