

Coronavirus impact on Internet use

29% internet traffic growth after lockdown in Spain has been maintained for a month

Netflix and YouTube are now offering access faster than pre-lockdown speeds

Amazon.com access speeds continue to be over 70% slower than pre-lockdown

At peak times network speed in EU27 are 6% slower than at lowest use times. In the US the figure is 4.4%

In some locations that have suffered the most Covid19 deaths peak time network speeds are much slower than national averages

Tech4i2 Ltd. 17th April 2020



Introduction

This is the third in a series of papers investigating how well internet infrastructure is coping with increased internet use after lockdowns.

This paper provides an update on 36 countries in Europe. It also includes a comparison of European internet performance with North America.

This paper provides an update of analysis for data collected on 9th and 10th April, one week after the last post-lockdown analysis. This was the Easter weekend. It is possible that the national holidays in most European countries on Good Friday (10th April) might have led to some changes in behaviour.

Internet traffic increase in Spain

Previous reports have analysed daily traffic for more than seven weeks for the DE CIX backbone router in Madrid, Spain. Analysis provides insights to internet traffic before and after lockdown. Similar patterns can be found for routers in other locations throughout Europe.

The adjacent graphic (blue title) presents the weekly average peak flows in Madrid (calculated by averaging daily peak flows; weekly calculations commence on a

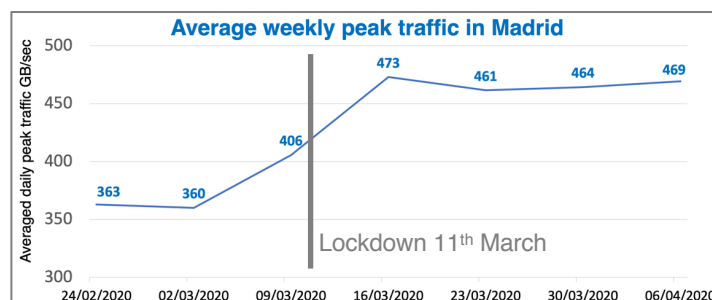


Monday). The grey line in the graph shows when lockdown was introduced in Madrid (11th March).

In the two weeks prior to shut down (24th February to 8th March) average daily peak flow was 361 GB/second.

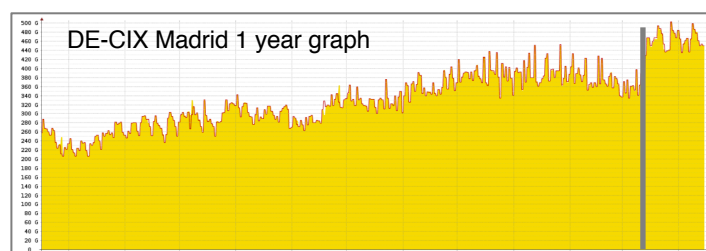
In the first week after lockdown (w/c 16th March) average traffic flows increased by 31 per cent to reach 473 GB/second.

In our first report we noted a slight downturn after the first week of lockdown and questioned how far traffic flows might return to 'normal' pre-lockdown levels. As the graph shows traffic, in the four weeks since lockdown, has remained relatively stable at an average (peak traffic rate of) 466 GB/second. This is an increase of 29 per cent on the pre-lockdown average.



The yellow graphic below shows the steady increase in internet traffic during the last year in Madrid. The increase in traffic between February 2019 (avg. 230 GB/sec) and February 2020 (avg. 360 GB/sec) was 56 per cent.

The 29 per cent increase due to lockdown is obviously large and did occur over only five days. But it should not be viewed in isolation from the steady increase in traffic which is accommodated by internet infrastructure on a regular basis throughout Europe and globally.



Where is network pressure the greatest?

Network pressure is likely to be highest on web sites that attract the most traffic. Tech4i2 analysis examines internet speeds for the most popular web sites in Europe from seven countries (Germany, Italy, Latvia, Lithuania, Netherlands, Sweden and the UK).

A fast connection speed (low number of milliseconds [ms]) enables rapid exchange of information between a user and a web site. Slower connection speeds, indicated by an increase in milliseconds, mean that information takes longer to download and video links might become jittery. A decrease in connection times is desirable because information will flow faster. An increase in access speeds is undesirable and can indicate stress on a network or a web site.

Speed tests to the most popular web sites were undertaken on Thursday 5th March, before the first lockdowns. The tests have been repeated four times after lockdowns, starting 26th March, on the same day (Thursday) and time (15.30 GMT) each week.

When first examined after lockdowns on 26th March, see the blue bars in the adjacent graphic, access speeds to many web sites had increased considerably and access speeds (ms) had risen. Amazon.Com access speed had fallen by 79 per cent. This loss was thought to be associated with increased desire for home delivery to prevent visiting shops.

The Facebook and twitter social media sites also suffered considerable slowing down in access speeds (58 and 43 per cent respectively).

The New York Times reported significant increases in web site internet traffic and stability or decline in mobile apps. This probably reflects more people using desktop and laptop computers and tablets when accessing sites from home during lockdowns. Facebook website use has increased by 27 per cent, Netflix by 16 per cent and YouTube by 15 per cent. These figures are for use in the US. But similar increases will have taken place in Europe.

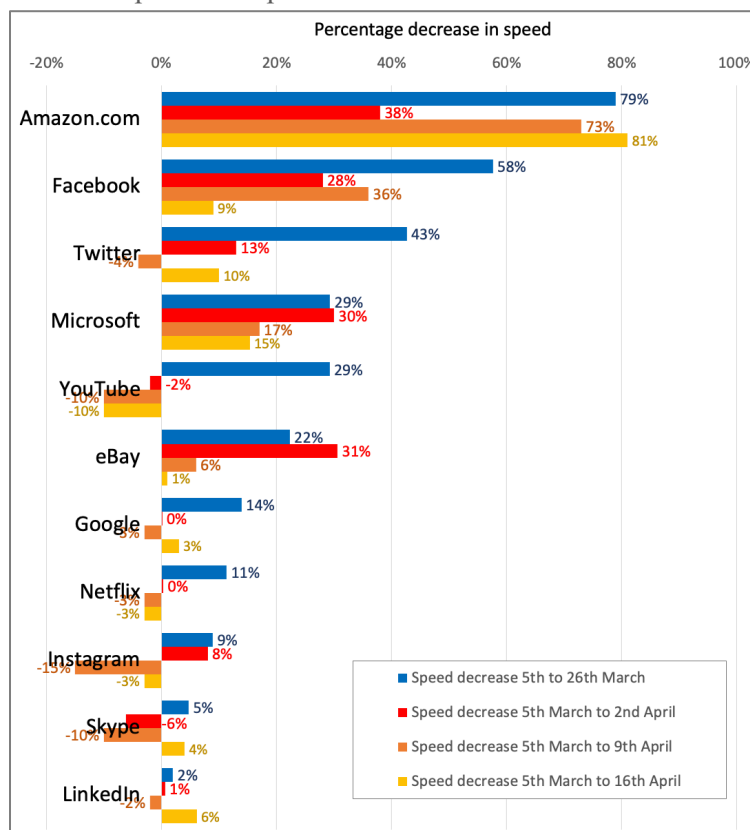
It is evident that on 2nd April, one week after the first post-lockdown data collection, many of the leading web sites had taken measures to address the slower access speeds, see the red bars in the graphic.

Amazon.com, Facebook and Twitter saw improvements in access speed, but they were still 38, 28 and 13 per cent slower (respectively) than pre-lockdown.

On 26th March, after lockdown, the three video rich web sites investigated - YouTube, Netflix and Skype - recorded slower access speeds of 29, 11 and 5 per cent respectively. One week later, on 2nd April, all three (and Google) had managed to return access speeds to their pre-lockdown levels, and for YouTube and Skype

access speeds were slightly better than they were prior to lockdown (2 per cent and 6 per cent faster respectively).

The orange bar on the graphic shows changes in access speeds on 9th April. The three video rich web sites continued to improve access speeds. All had faster access speeds than prior to lockdown.



One explanation for this relatively dramatic improvement is that for most of the other leading web sites examined the impact of speed reductions will be negligible for most users. But for those accessing videos and VoIP calls slower speeds could result in 'jittering' and 'freezing' of content. Maintaining fast access speeds (lower ms) for these sites was therefore important to sustain user satisfaction.

The graphic also shows that by 9th April Twitter, Google, Instagram and LinkedIn have all improved access speeds to provide faster access than prior to lockdowns. Conversely, to the other nine sites examined, Amazon and Facebook both experienced decreases in access speed when examined on 9th April, Amazon access speeds rose to 73 per cent higher than prior to lockdowns and Facebook to 36 per cent.

During the last week (see the yellow bars for comparison between 5th March and 16th April) access speeds to six sites had slowed (e.g. an increase in ms access for Amazon, Twitter, Google, Instagram, Skype and LinkedIn). Three sites had further reduced their access speeds (Facebook, Microsoft and eBay). YouTube and Netflix maintained access speeds at the

levels recorded in the previous week (collected on 9th April).

The graphic shows that nine of the eleven have now returned their access speeds to within ten per cent of levels recorded prior to lockdowns. Two video rich web sites - YouTube and Netflix - now have access speeds lower than recorded pre-lockdown.

Amazon is struggling to reduce access traffic speeds. In the last week their average access speed rose to the slowest speed recorded since lockdown.

Network pressure and slower internet speed

Changes in traffic speed are a good indicator of stress on the internet network and the resilience of infrastructure.

Access times to the eleven leading web sites are collected from seven countries. The graphic below shows average web access speeds (in milliseconds) for the seven countries.

The blue bar in the graph presents access speeds prior to lockdowns on 5th March.

Our previous paper noted that access speeds are determined by the amount of network infrastructure (cloud and edge servers, backbone routers and internet exchanges) in the proximity of the user. Germany and the Netherlands have relatively high level access to network infrastructure and access speeds were low (7.3 ms and 8.7 ms respectively on 5th March).

Lithuania and Latvia are not reported as having cloud or edge servers in their country. Their access times to the eleven leading web sites are therefore significantly higher than the other countries in the graphic (21.5 and 23.8 ms respectively on 5th March).

earlier data has been collected every Thursday since 26th March.

The red bar for data collected on 26th March shows initial relatively large decreases in access speeds after lockdown for all countries except Germany.

The orange bar shows that one week later on 2nd April access speeds had improved, but were still slower than pre-lockdown, in all counties except Sweden, where significant improvements in access speed were achieved. These have subsequently been maintained.

The green bar in the graphic presents data collected on 9th April. This shows further improvements in comparison with the previous week for access speeds in the Netherlands and Italy and Lithuania.

Latest results for the 16th April (yellow bars) show decreases in access speeds in the Netherlands, Sweden, UK and Latvia. After achieving a significant decline when analysed on 9th April, average access speeds in Italy rose by 34 per cent to 9.5 ms.

The red percentage numbers to the right of the bars provides details of the increase in access speeds on 16th April compared with 5th March. Most countries recorded significant increases in access speeds after lockdowns and subsequently reductions have occurred. Contrary to this general trend speeds in Germany have recorded small increases in each of the five surveys. The overall increase in Germany is 11 per cent. The highest increases of 25 per cent has been recorded in the Netherlands. This is slightly puzzling because the country has a high ratio of network infrastructure per person in comparison with most other countries in Europe. However, is finding is supported with evidence of ‘stress’ observed in Amsterdam and Rotterdam, see the next section.

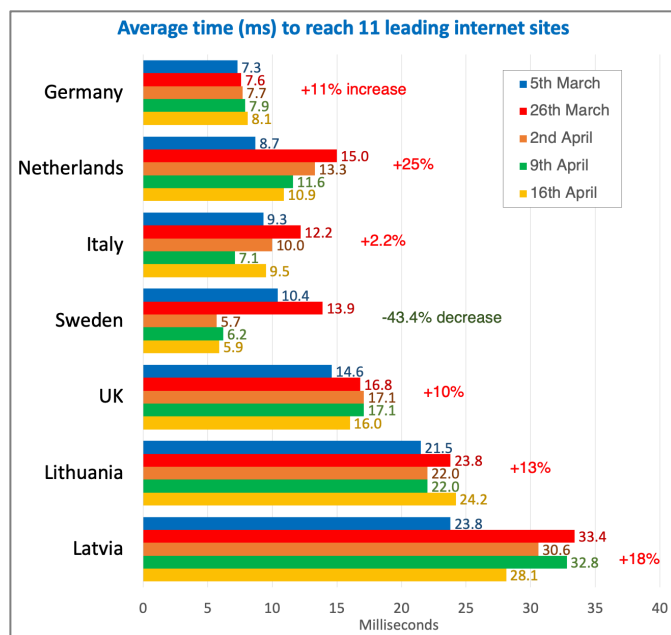
Sweden is the only country to have recorded a decrease in access speeds – 43.4 per cent. Significant reductions were identified on 2nd April and these have been maintained. Sweden is one of three countries in Europe not to introduce lockdowns.

Peak and trough stress test Europe

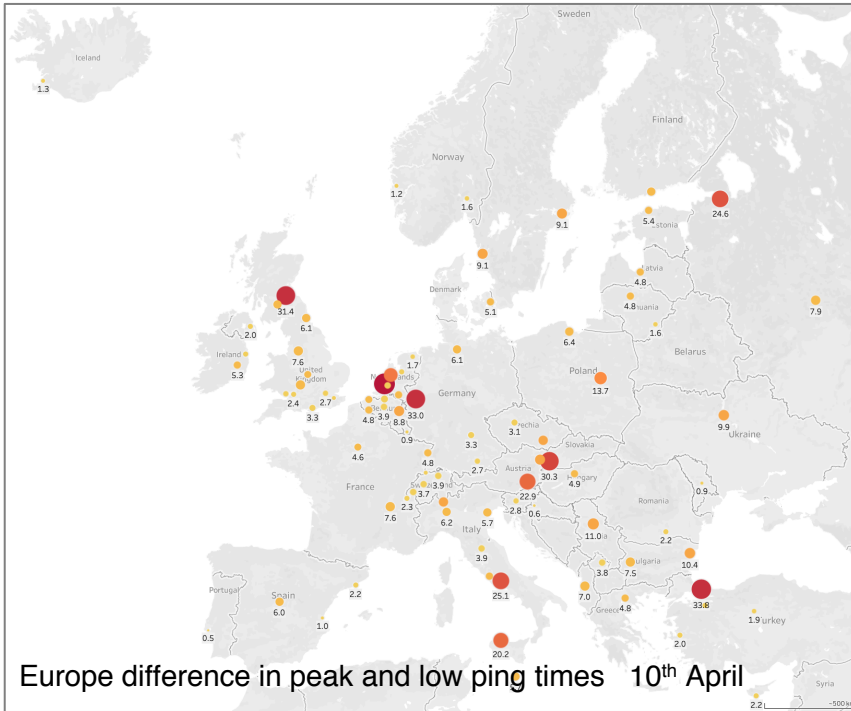
To provide further insights to infrastructure resilience Tech4i2 commenced weekly collection of internet speed data in 97 cities in Europe and 67 cities in North America on 3rd April.

Our working hypothesis is that stress in the network can be investigated by examining traffic speeds at the busiest time of day and comparing that with the time when there is likely to least traffic and thus infrastructure is probably under minimum stress. Henceforth this is called the ‘low’ or ‘low point’.

DE CIX and other backbone routers reveal that the busiest time of day is Friday evenings and the quietest



The different coloured bars on the graphic show changes in access speeds after lockdowns. As noted



Europe difference in peak and low ping times 10th April

time of day is 4 to 6 am in the morning. Data collection therefore takes place on Friday evenings and Saturday mornings.

Europe and North America both have three hour time differences between 'mainland' western and eastern locations. Data collection therefore takes place at 22.00 on the Eastern edge of the continent (this is 19.00 on the western edge). The following morning data is collected at 06.00 on the Eastern edge of the continent.

Data is collected using ping tests. A ping is a signal sent from a location that requests a response from a computer or host at a different location. Ping tests can check if the host is operating or available. A useful element useful for our study is that ping testing also measures how long it takes to obtain a response between two locations. In Europe each of the 97 locations pings every other location and the total time of pings is recorded from one location to the 96 other locations (9,312 data points in total). A similar method is used in North America for 67 cities in the United States and nine in Canada.

Initial results for 3rd and 10th April suggest stress on the infrastructure viewed at country level is limited. In EU27 Member states ping times were 7.2 per cent higher at peak times than the low point on April 3rd. One week later this had decreased to a 6 per cent difference.

The table shows differences in stress levels for different geographical areas

Differences for EFTA countries (3.3 per cent 3rd April; 3 per cent 10th April) showed an improvement during the first week of analysis.

In the Western Balkans (6.0 per cent; 7.1 per cent) there was an increase suggesting a little more stress.

In other parts of Europe (one location in Georgia, Moldova, Ukraine and Russia [5 locations]) delays increased (from 8.6 per cent to 11 per cent). These figures are inflated by average increases in Russia of 20.5 per cent on 3rd April and 18.6 per cent on 10th April

US figures (4.9 per cent; 4.4 per cent) were slightly lower than EU27, but not as good as EFTA or Canada (2.4 per cent; 1.8 per cent respectively).

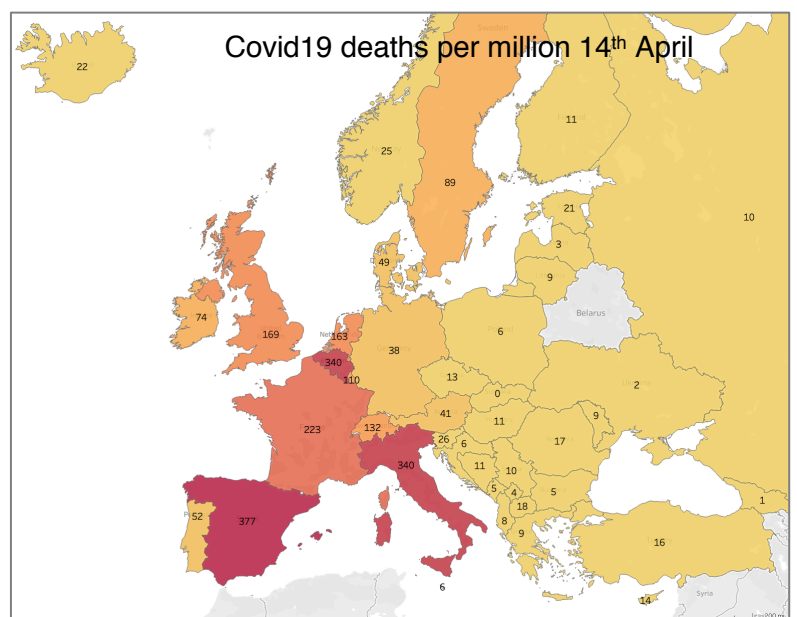
These aggregate figures are interesting, but the real benefits arise when one examines a map of ping times from the cities. Interestingly, ping time analysis in the Netherlands confirms the finding in previous papers. In Amsterdam the difference between evening peaks and the morning is 17.0 per cent and in Rotterdam it is even higher at 38.6 per cent on 10th April. Nearby Dusseldorf has also recorded a high level of stress (33.0 per cent).

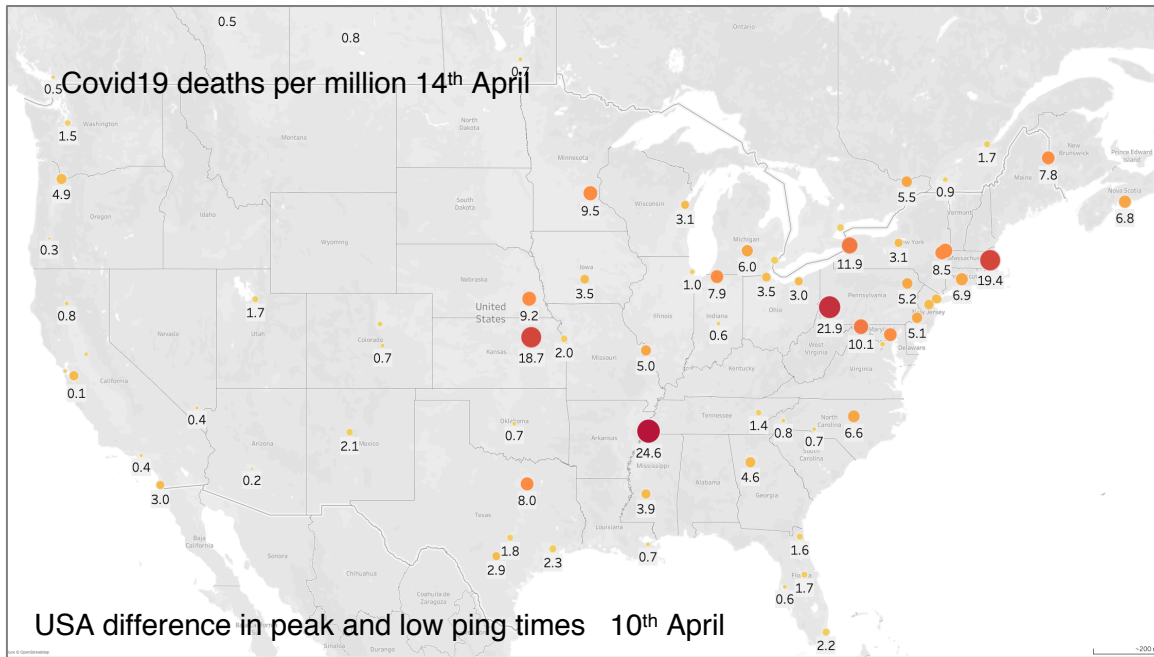
	Percentage difference 3 rd April	Percentage difference 10 th April
EU27 (60 locations)	7.2%	6.0%
EFTA (21 locations, inc UK)	3.3%	3.0%
Western Balkans (8 locatns)	6.0%	7.1%
Other Europe (8 locations)	8.6%	11.0%
USA (67 locations)	4.9%	4.4%
Canada (9 locations)	2.4%	1.8%

EFTA- CH, IS, NO, UK. Western Balkans- AL, BA, XK, ME, MK, RS, TR. Other- GR, MD, RU, UA

Other cities with large differences are Frosinone (25.1 per cent increase) and Palermo (20.2 per cent); both in Italy.

There also appears to be an area of stress in the vicinity of Bratislava (30.3 per cent; Slovakia) and Graz (22.9 per cent; Austria) in central Europe.





The area suffering the most in the United States, and possibly in the world, is New York (508 deaths per million). Its north-eastern US neighbours New Jersey (273), Connecticut (168) and Massachusetts (124) are also amongst the areas suffering most in the US.

A focus for our post lockdown study has been an examination of the resilience of internet infrastructure during the pandemic. We have highlighted that internet hardware appears to be resilient, but noted that the task of managing and maintaining the infrastructure, particularly when problems arise, is undertaken by humans who are susceptible to coronavirus.

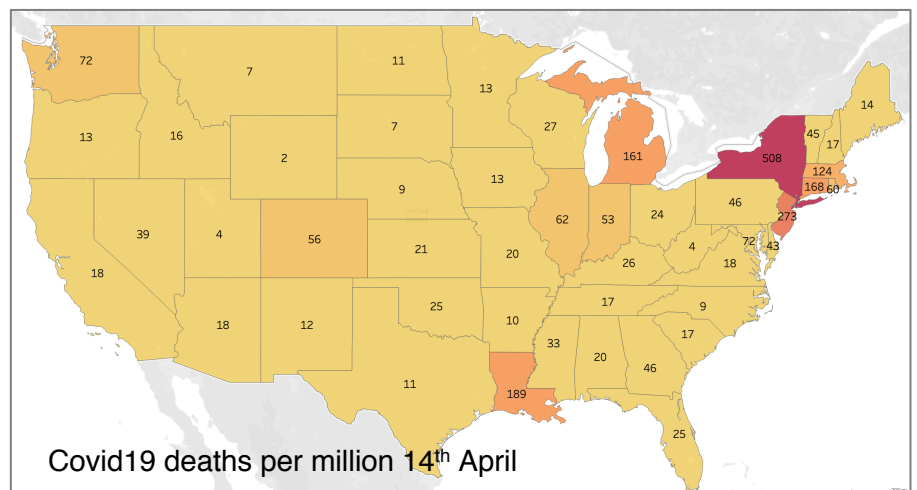
We are undertaking statistical analysis to investigate reasons for variance in network performance. One component to be included in regression analysis is the number of deaths incurred in different countries in Europe and States in the US.

	Covid19 Deaths (per million) 14 th April
EU27	149
EFTA	155
Western Balkans	15
Other Europe	4
USA	73
Canada	21

EFTA- CH, IS, NO, UK, Western Balkans- AL, BA, XK, ME, MK, RS, TR. Other- GR, MD, RU, UA

The graphic on the previous page showed the number of deaths per million of the population in different countries in Europe. The total number of deaths (per million population) on 14th April was highest in Spain (377). Belgium and Italy have suffered the second highest number of deaths (both 340). As the graphic shows highest death rates have been recorded in central and south-western Europe. Two exceptions are the relatively low death levels in Portugal (52). Sweden, which has not introduced lockdown measures, has higher (89) death levels than its Scandinavian partners (Denmark 49, Norway 25 and Finland 11).

It is notable that in the US map (below) the difference between peak and low ping times are generally highest in the north-eastern US. Western US states have some of the smallest differences between peak and low times of any of the 164 locations examined in North America and Europe.



Conclusions

This third paper reports data collected up to 16th April. Reductions in speed within many countries and to many leading sites are still evident. But marginal improvements on the previous week are apparent.

After significant decreases in access speeds to leading web sites the majority have now returned their access speeds to within ten per cent of levels recorded prior to lockdowns. Two video rich web sites - YouTube and Netflix - now have access speeds lower than recorded pre-lockdown. Amazon is struggling to reduce access traffic speeds. In the last week their average access speed rose to the highest levels recorded since lockdown.

Our new ‘peak and trough’ stress test provides an insight to where problems exist in European and North American cities. Differences in peak and low traffic speeds in EU27 were 6 per cent on 10th April. In the US the difference was 4.4 per cent on the same date. Maps have shown that there could be a relationship between areas suffering most with covid19 and the locations where internet infrastructure appears to be most stressed.

Statistical analysis next week will examine the strength of this relationship. We will also investigate the extent to which network infrastructure (cloud and edge data centres and internet exchanges) in a locality contributes to differences in network speeds in different countries and states.

As lockdowns are eased we will continue to undertake analysis. Changes in internet use and speeds might be revealed over the next four weeks as lockdown restrictions are reduced. Country announcements include:-

Austria: Public parks, small shops, DIY and gardening supply stores reopened. All stores to reopen on 2 May, restaurants in mid-May;

Czech Rep: small shops reopened April 9. Markets and craft shops on April 20. Larger shops on April 27;

Denmark: Daycare centres and primary schools reopened on 15th April. Some small businesses, such as hairdressers, will reopen on April 20;

France: Nurseries and schools will progressively reopen from May 11;

Italy: Bookshops, laundries, stationers, children’s clothes stores reopened in some regions from April 14th. Forestry workers and IT manufacturers are back at work. Full lockdown set to end 4 May;

Norway: Kindergartens to reopen and some health specialists to return to work from 20 April. Partial reopening of high schools and universities, hair and beauty salons from 27 April.

Note

Covid19 data was obtained from John Hopkins University <https://github.com/CSSEGISandData/COVID-19>. Due to differences in virus testing levels between countries death data was used instead of ‘confirmed cases’.

It is acknowledged that the reporting of deaths also varies. Some countries only report deaths in hospitals, others report all deaths regardless of location.

Lockdown exit plans were obtained from the Mason R and Stewart H. 2020. UK government has no exit plan for Covid-19 lockdown, say sources. Guardian. 15th April.

<https://www.theguardian.com/world/2020/apr/15/uk-government-has-no-exit-plan-for-covid-19-lockdown-say-sources>

Tech4i2

Tech4i2 is an international technology consultancy company with offices in the UK and Ireland. Tech4i2 have developed digital indexes to monitor internet use by citizens and businesses in more than 60 countries. Monitoring activities include examining connectivity speeds with web sites and between different countries around the globe.

Internet speed monitoring is undertaken by Tech4i2 on the same day of the week and at exactly the same time of day to maximise comparability and control for extraneous events. Further insights to network performance will be provided in the future.

We believe the majority of change in our comparisons before and after lockdowns is due to the impacts of coronavirus. But as our first coronavirus report highlighted the way internet traffic is routed is very complex.

pdfoley@tech4i2.com

@Tech4i2

This paper can be found at <http://www.tech4i2.com>.



Insights into innovation and inclusion