Exiting Lockdown

Policy Exchange

Using Digital Contact Tracing to Defeat COVID-19

Richard Walton and Julie Marionneau

Exiting Lockdown

Using Digital Contact Tracing to Defeat COVID-19

Richard Walton and Julie Marionneau

About the Authors

Richard Walton is a Senior Fellow at Policy Exchange and a Distinguished Fellow at the Royal United Services Institute (RUSI). A former Commander at New Scotland Yard, he served in the Metropolitan Police for thirty years (1986-2016) and was Head of the Metropolitan Police Counter Terrorism Command (SO15) between 2011-2016. He holds a BSc Hons degree in Policing and Police Studies from Portsmouth University and a MSc in International Relations from the London School of Economics and Political Science (LSE).

Julie Marionneau is a Research Fellow working for the Judicial Power Project at Policy Exchange. She primarily was a Major and Legal Adviser in the French Air Force where she specialised in Law of Armed Conflict, Operational Law and Air Law. She was recently a legal and military expert working for the Under Secretary General Ms. Jane Holl Lute at the United Nations Secretariat in New York, and a Legal Adviser in NATO at the Joint Force Command in Naples. During her career, she assumed responsibilities of Legal Adviser to the Air Defense Operational Command in France as well as in various military deployments (Libya, Afghanistan, Qatar, Kosovo). She was also appointed outside the realm of the military institutions to work for the General Secretariat for National Defense and Security (Prime Minister) in Paris where she developed an expertise in armament export control regulations and policies. She is currently a part-time doctoral student in the Department of War Studies, King's College London.

Contents

Foreword

By Richard Walton

The UK Government is currently in the eye of the storm, fighting to save lives and galvanising the nation to support the response to the COVID-19 crisis.

But when the worst of this current storm passes, how will it prevent a second COVID-19 epidemic from sweeping through the country, potentially more deadly than the first, triggering a second economic downturn?

There are no easy answers:

> *"Even a perfect response won't end the pandemic. As long as the virus persists somewhere, there's a chance that one infected traveller will reignite fresh sparks in countries that have already extinguished their fires".*[1]

By most estimates, a rollout of a vaccine is 12-18 months away at best and a complex challenge because there are no current vaccines for coronaviruses and the implementation of mass immunisation will be a major policy and planning endeavour.

> *'NIH infectious disease leader Anthony Fauci has said it could take 12 to 18 months to make a vaccine available, but even that timetable could be overly ambitious".*[2]

It is possible that the dynamism and current pace of innovation within the global medical research community could shorten this vaccine development timespan[3] if results from tests are shared between countries and pharmaceutical companies, but strong ethical and regulatory safeguards that hold back fast development will still need to be applied.

'Herd immunity'[4] will not be achieved quickly and the virus is likely to re-emerge in a peripatetic fashion for years to come:

> *'The end of this epidemic is going to require nearly 50% of the population to be immune, either from a vaccine, which is not on the immediate horizon, or from natural infection[5]'*

This means that a future 'suppression' strategy will need to include three pillars that are all inter-related: i) intermittent social distancing ii) swab testing and iii) contact tracing.

The WHO Director General has been explicitly clear how important these three pillars are:

> *"We haven't seen an urgent enough escalation in testing, isolation and contact tracing, which is the backbone of the response… social distancing measures were not enough on their own to extinguish this epidemic"*[6.]

1. https://www.theatlantic.com/health/archive/2020/03/how-will-coronavirus-end/608719/
2. https://www.politico.com/news/2020/03/20/why-the-push-for-a-quick-coronavirus-vaccine-could-backfire-139854
3. https://www.nature.com/articles/d41573-020-00073-5
4. "When enough of the population is resistant to a germ, its spread stops naturally because not enough people are able to transmit it. Thus, the "herd" is immune, even though many individuals within it are not." https://www.tecnologyreview.com/s/615375/what-is-herd-immunity-and-can-it-stop-the-coronavirus/
5. https://www.technologyreview.com/s/615375/what-is-herd-immunity-and-can-it-stop-the-coronavirus/
6. https://www.independent.co.uk/news/health/coronavirus-test-world-health-organisation-uk-contact-tracing-chris-whitty-phe-a9405476.html

Social distancing, if stringently applied, is the only one of these tactics that severely curtails freedom and liberty - enforced through emergency movement restrictions ("lockdown"). Enforcing measures in this way across the entire country is unsustainable in even the medium term if the country is to have any chance of economic and societal recovery and when the Government lifts the current emergency restrictions in the UK, the tactics of testing and contact tracing become significantly more important.

This paper assumes that the Government will achieve its declared aim of significantly uplifting the planned suite of testing measures across the country in a short time frame (through its 'Five Pillar testing strategy[7]).

In time, large sections of the population will be swab tested (whether antigen or antibody testing[8]) to see whether they are carrying or have had the COVID-19. The importance of this is clear:

> *'Tests to detect antibodies will also be able to identify those who have had infections in the past and may now be immune. In the short term, this will be important because it will permit the authorities to identify who may return to their jobs without risk of infecting others'[9].*

Analysis of the data amassed from testing will greatly assist in understanding how the virus has spread and is spreading but will not in of itself prevent future outbreaks and suppress the virus. It will provide an insight into the challenge being faced and enable targeted social isolation to be implemented but will not give us a solution to wipe out the virus from our communities entirely.

This paper focuses on 'contact tracing', the only other tactic now universally viewed as critically important to combating the further spread of the virus within and across nation states, once restrictions have been lifted. In particular, it focuses on the legal and ethical aspects of the various digital tracing methodologies being used and tested around the world.

Contact tracing can quash existing and prevent future outbreaks but if undertaken manually it has been proven to be wholly inadequate against COVID-19.

Technology can, however, provide a force multiplier effect (using automated AI technology on contact tracing), allowing those who have been in contact with an infected person in a matter of hours or days to immediately self-isolate, thereby limiting the further spread of the virus. This may look like the world playing:

> *"a protracted game of whack-a-mole with the virus, stamping out outbreaks here and there…"[10]*

but alongside testing, it is the least intrusive option but the most difficult to implement.

For some time, Asian governments (both democratic and undemocratic) have been turning to technological solutions to radically improve the success rate of contact tracing. All forms of technology have been used including phone data, GPRS location monitoring, facial recognition and the use of data retrieved from smartphone 'Applications' (Apps).

7. https://www.sciencemediacentre.org/expert-reaction-to-publication-of-detail-of-five-pillars-of-how-the-government-intends-to-scale-up-COVID-19-testing-programmes/
8. https://www.biospace.com/article/fda-approves-1st-covid-19-antibody-test/
9. https://www.economist.com/science-and-technology/2020/04/01/an-antibody-test-for-the-novel-coronavirus-will-soon-be-available
10. https://www.theatlantic.com/health/archive/2020/03/how-will-coronavirus-end/608719/

However, the use of these techniques is controversial, intrusive and in most countries unregulated.

Scientists from Oxford University are now clear about the usefulness of using technology to solve the COVID-19 dilemma of preventing further outbreaks once restrictions on movement have been lifted:

> *'We conclude that viral spread is too fast to be contained by manual contact tracing, but could be controlled if this process was faster, more efficient and happened at scale. A contact-tracing App which builds a memory of proximity contacts and immediately notifies contacts of positive cases can achieve epidemic control if used by enough people. By targeting recommendations to only those at risk, epidemics could be contained without need for mass quarantines ("lock-downs") that are harmful to society'*[11]

Alongside European countries and the USA, the UK Government is exploring digital solutions and the utility of a voluntary monitoring App developed by the NHS[12] for use by the population as part of its 'exit strategy', to help the Government trace those who have been in contact with infected persons in order for them to be instructed to self-isolate, thereby limiting the spread of the virus.

Whilst the utility of similar Apps used in countries such as China, Singapore and South Korea is without question, the introduction of Big Data acquired by the UK Government in this way raises profound ethical, legal and operational questions.

Commenting on the future 'contact tracing' strategies governments of the world should deploy to tackle the coronavirus, the author Yuval Noah Harari recently said:

> *"In this time of crisis, we face two particularly important choices. The first is between totalitarian surveillance and citizen empowerment. The second is between nationalist isolation and global solidarity*[13]*".*

> *"In recent years both governments and corporations have been using ever more sophisticated technologies to track, monitor and manipulate people. Yet if we are not careful, the epidemic might nevertheless mark an important watershed in the history of surveillance. Not only because it might normalise the deployment of mass surveillance tools in countries that have so far rejected them, but even more so because it signifies a dramatic transition from "over the skin" to "under the skin" surveillance.*

> *"we now face a choice as to whether we turn to totalitarian surveillance or whether we turn to empowering citizens in order to stop this… I am in favour of surveillance as long as it goes both ways and doesn't result in an authoritarian regime like we're seeing in Hungary and other countries around the world"*[14].

There are three critical questions that the UK Government needs to consider as it considers introducing the widespread use of an App across the population for contact tracing:

11. https://science.sciencemag.org/content/early/2020/03/30/science.abb6936.full
12. https://www.telegraph.co.uk/news/2020/04/05/revealed-coronavirus-exit-strategy-mass-testing-contact-tracing/
13. https://www.msn.com/en-gb/money/news/yuval-noah-harari-the-world-after-coronavirus/ar-BB11rdUm?li=AAnZ9Ug
14. https://www.msn.com/en-gb/money/news/yuval-noah-harari-the-world-after-coronavirus/ar-BB11rdUm?li=AAnZ9Ug

- Will usage of the App be made compulsory or voluntary?
- How and for how long will the data be stored, and by whom?
- Who will analyse the data and for what purpose will it be used?

But there is a wider question too:

- Is limiting privacy a price worth paying for freedom and liberty?

This paper concludes that a future over-arching 'suppression' strategy for the country, once restrictions have been released, should focus on two main pillars: **Testing and Tracing**.

In order to make a future Testing and Tracing strategy effective, the UK Government needs to extend its Five Pillar Testing Strategy to a Six Pillar **Testing and Tracing Strategy** by introducing digital contact tracing as a Sixth Pillar.

It also needs to urgently invest in digital solutions including introducing a voluntary App (such as the TraceTogether App launched by Singapore) to greatly assist with analysing data from testing and to improve contact tracing of those who have been in contact with an infected person, which in turn will assist the prevention of a further potentially more serious outbreak of the virus in the future.

It concludes that making the App compulsory would be counter-productive and do more harm than good to British society, legitimising fears of the UK becoming a 'surveillance state' and unnecessarily alienating a section of the public who are wedded to their personal privacy.

In order to be effective, a high percentage of the population will need to be using an App of this kind, a subscription percentage that can only be achieved by the Government providing reassurances on how the data will be stored, analysed and used. High levels of trust will be vital to getting a critical mass of people to subscribe to the App and use it routinely. Use should also be time limited and not indefinite in order to reassure people that their data is being used solely to address the current crisis that the nation is facing.

Legislation should be introduced to set the parameters for authority levels to acquire, use, store and retain data, incorporating safeguards and taking account of the Data Protection Act 2018, Human Rights Act 1998 and other relevant legislation.

Alongside legislation, in order to shift the Government's counter COVID-19 towards a more proactive rather than reactive strategy, it should also create a new cross-Government and multi-agency 24-7 national **Testing and Tracing Command Centre**, led by a single individual experienced in Command, Control, Co-ordination and Communication (C4) to combine the skills and expertise of different parts of Government and agencies. This would include analysts and intelligence professionals from Public Health, NHS, Local government, police, military, intelligence agencies, private sector, in particular, the technology sector and other Government departments.

The **Testing and Tracing Command Centre** would be modelled on similar examples in Taiwan and Singapore and those within Counter Terrorism, having a 24/7 tactical fusion capability similar to those used by the military, police and intelligence agencies (e.g. National Police Counter Terrorism Network, Joint Terrorism Analysis Centre (JTAC)). The role of the centre would be to oversee and implement a national testing and tracing strategy for hunting down and defeating Covid-19.

The Centre should be an independent body (much like the UK Statistics Authority) and not part of the police or intelligence agencies, to avoid concerns or a perception that it is simply an arm of the state.

The UK population now understands the severity of social distancing measures. Looking forward, the public will want to contribute to any strategy that limits or prevents a repeat of the enforcement measures it has been subjected to. A post lockdown strategy should use all available measures and technologies to significantly upscale analysis of testing and contact tracing in order to defeat COVID-19.

In order to achieve this, the UK public will need to be convinced that the price of giving up some of their privacy is one worth paying to secure their freedom.

This paper concludes that the UK public will forfeit some of their privacy for their freedom in order to defeat COVID-19 but a public debate on this issue will be necessary to assist people's understanding of how much privacy will actually be lost and where boundaries will lie.

Policy Recommendations

- The UK Government should extend its Five Pillar **Testing Strategy** to a Six Pillar **Testing and Tracing Strategy** by introducing digital contact tracing as a Sixth Pillar.
- A **Testing and Tracing Strategy** should bring together expertise from the Department of Health, NHSX, NHS Digital, Police, Military and the Intelligence Agencies, to create a new independent national 24/7 **Testing and Tracing Command Centre** responsible for:
    - analysis of the spread of the coronavirus across the country through use of testing results and advanced contact tracing using digital technologies
    - using the analysis to enforce self-isolation / social distancing in outbreak hotspots in fast time to suppress / extinguish the virus from the country.
    - communicating to the public key messages in relation to the counter COVID-19 strategy (in place of the current Government daily briefings)
- The **Testing and Tracing Command Centre** should accelerate the development of digital solutions and urgently launch a national voluntary App to significantly improve 'contact tracing' of those infected with coronavirus. Digital solutions should protect privacy whilst achieving the purpose of obtaining tracing data that can be acted upon.
- The Government should appoint a single operational lead for the **Testing and Tracing Command Centre**, experienced in national Command, Control, Co-ordination and Communication (often referred to as C4).
- The Government should legislate to regulate how the data from a **Testing and Tracing Command Centre** is acquired, stored, analysed and used, introducing necessary ethical and privacy safeguards and for a time limited (renewable) period.
- The Government should make a national appeal (via a national advertising campaign) to the UK population to subscribe to the voluntary App explaining that the public will need to forfeit some privacy for freedom and liberty in order to defeat the pandemic. Role models and internet influencers should be used to encourage take up of the App, distinguishing it from other Apps currently being circulated and used.

- The Government should give consideration to active steps, including public debate, that can be taken to enhance the technological skills (e.g. use of smartphone Apps) of some people who are not currently skilled, including some older people, in order to increase levels of compliance with use of a voluntary digital App when it is introduced. This could be achieved by enlisting the support of NHS volunteer responders.

Executive Summary

Evidence base for using digital contact tracing methodologies to counter COVID-19

- The recent outbreak of COVID-19 has exposed the limitations of traditional manual contact tracing methodologies, a fact that leaders of some Asian economies (e.g. China, South Korea and Singapore) had already understood following their handling of previous pandemics.
- When considering the measures needed to counter the further spread of COVID-19 once isolation measures have been relaxed, there is a strong body of evidence emerging from around the world that supports the use of digital contact tracing methodologies alongside a comprehensive mass testing regime.
- Recent research by Oxford University concludes that a contact-tracing App which builds memory of proximity, contacts and immediately notifies contacts of positive cases, can achieve epidemic control if used by enough people and that epidemics could be contained without need for mass quarantines ('lock-downs') that are harmful to society.
- Research shows that the use of mobile phone data can offer a 'critical contribution to four broad areas of investigations: **Situational awareness** (trends and geographical distribution), **Cause and effect** (identifying key drivers and consequences of implementing different measures to contain the spread of COVID-19), **Prediction** (to enable new predictive capabilities and allow stakeholders to assess future risks, needs and opportunities), **Impact assessment** (to identify obstacles hampering the achievement of certain objectives or the success of particular interventions).

Development of digital technologies to combat COVID-19

- Many different governments around the world have introduced digital contact tracing Apps in an attempt to suppress the spread of COVID-19. For instance, over 700 million people in China are using the Chinese '**Health Code'** application, run by the Chinese Government with individuals being able to sign up through a wallet App called 'Alipay' run by the tech firm Tencent.

- The Singapore Government has introduced a voluntary App '**TraceTogether'** that encourages users to "help" in the contact tracing process and which can be downloaded by anyone using a Singapore mobile number and a Bluetooth enabled smartphone. The App has several layers of security and privacy safeguards in place.
- A Swiss not for profit consortium (called PEPP-PT) of European technological companies is developing a mobile phone App similar to **TraceTogether** in Singapore. PEPP-PT has more than 130 members across 8 European countries and includes scientists, technologists and experts from well-known international research institutions and companies.
- Several European countries are independently developing or intending to develop a smartphone App to assist with contact tracing. For example, the Polish Government has launched a voluntary smartphone App called '**Home Quarantine**' for their own nationals returning back to Poland from abroad who are required at the moment to self-isolate for two weeks.
- The UK is developing a voluntary App to assist with contact tracing. Work is being led by NHSX, the NHS's digital board.
- It has been reported that around 1.5 million Israelis have already downloaded the government's mobile App '**HaMagen**' ('The Shield') and that in its first week of usage 50,000 App users reported that they had self-quarantined.
- Leading private technology companies have been exploring ways of using technology to assist combating the COVID-19.
  - Apple have released a new screening App '**COVID-19'** that gives trusted information and guidance and which is available on its App Store.
  - Google has launched COVID-19 **Community Mobility Reports** that are designed to provide insights into what has changed in response to policies aimed at combating COVID-19. The reports chart movement trends over time by geography, across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential.
  - Facebook have introduced a new pop up on its platform asking users to fill out a COVID-19 symptom **mapping survey** from the Delphi epidemiological research center. The initiative is part of its 'Data for Good' programme offering maps on population movement and aggregated sets of information that researchers can use to better understand how "population dynamics influence the spread of the disease".
  - Some researchers have also exposed flaws and vulnerabilities in Government approved coronavirus contact tracing Apps.

A future strategy for defeating COVID-19 once restrictions have been relaxed

- There is a close inter-dependency between the tactics of swab testing (whether antigen or antibody) and contact tracing. A successful 'Testing and Tracing' strategy will need to rely on both tactics being rolled out comprehensively across the UK.
- The effectiveness of a contact and tracing strategy is entirely dependent on speedy, and accurate positive test results identifying those who are infectious and who are spreading the virus, allowing for fast interventions by 'contact tracing' teams to interdict to prevent further spread.
- There is little merit in investing substantial sums of money and effort into a digital contact tracing strategy (using a digital App and contact tracing teams) if the UK is not able to identify quickly an extremely high percentage of those who have become infected. If swab testing is sufficiently prolific and resourced to be able to test anyone with an immediately identified symptom of COVID-19, then a comprehensive digital contact tracing strategy is worthwhile.

Privacy and legal dimensions of contact tracing

- There are legitimate concerns resulting from a government's use of mass data obtained via contact tracing smartphone Apps to trace and track COVID-19 and send personalised notifications to citizens. These revolve around the potential loss of privacy and the potential or perceived establishment of a state of mass surveillance during a health crisis that could have long lasting effects and impacts on civil liberties.
- The severity of the current emergency measures imposed on populations across the world are so severe that it is likely that most populations will be prepared to forfeit a potentially high degree of privacy as a trade-off for a restoration of their wider freedoms.
- The overarching GDPR framework provides for exemptions that make it feasible for the UK Government to create a bespoke legal framework to protect the rights of individuals in a post-lockdown context while ensuring that the UK authorities are able to tackle this unprecedented pandemic with the appropriate means and use of mass data obtained from smartphone and other technological sources.
- There are examples of privacy intrusions in countries using digital contact tracing mobile phone data including some businesses being subject to blackmail.
- Governments will need to convince their populations that they should give access to their personal health data on a regular basis

in the wider interests of the health of their nations. This is a major challenge and one that will need to be explained with transparency and openness.

Cultural and behavioural implications of digital contact tracing

- The successful implementation of a "privacy-friendly" digital contact-tracing App by the UK Government will depend on the willingness of the British people to adapt quickly to new norms in an extraordinary post-lockdown reality. The public will need to commit to a new social contract with its government, one that accepts that some infringements on privacy are a necessary prerequisite for restoring and maintaining wider freedoms.
- Whilst a high percentage of the UK population are regular users of digital technology, including smartphones, the Government will need to address some skills gaps (for instance, amongst some older people) in order to achieve a high level of subscription to a voluntary smartphone App.

Operational implications of digital contact tracing

- Taiwan has proven to be one of the best prepared nations in the world as regards a response to the Covid-19 epidemic, including having a National Health Command Centre that was established in 2004. Taiwan's strategy is a combination of big data, transparency and central command.
- The UK Government should now move to a 24/7 operational footing, treating COVID-19 as an enemy that needs to be suppressed and ultimately defeated. To that end, it needs to create a national 24/7 multi agency **Testing and Tracing Command Centre** responsible for the analysis of the spread of the coronavirus across the country through test results and advanced contact tracing using digital technologies. The centre should oversee analysis of the data and the enforcement of self-isolation / social distancing measures in outbreak hotspots in fast time to suppress / extinguish the virus from the country. It should also be responsible for communicating key messages to the public on the measures that are being taken, via websites and briefings, replacing the current daily national briefings that the Government is undertaking.
- Currently, nation states are operating independently, investing substantial sums of money in digital and other solutions that are country specific, yet many of these solutions could be universally applied if successful collaboration can be achieved. COVID-19 is a global challenge that requires global thinking and solutions.

Cyber security and digital contact tracing

- Inaccurate or misleading data entered onto voluntary Apps could have far reaching negative consequences, such as hackers or fraudsters entering data on a stolen or fraudulent smartphone in a crowded place in order to convince people that they have come into contact with someone suffering from COVID-19, potentially forcing large numbers of people to go into self-isolation.
- Malign actors could target particular groups using this technique with perverse ramifications on the use of police powers to enforce self-isolation in the future. Google and Apple and individual governments will need to explore how these negative outcomes can be prevented by taking account of them in the design stages of operating systems and smartphone applications.
- Some researchers have already exposed flaws and vulnerabilities in Government approved coronavirus contact tracing Apps.

Introduction

The UK Government is currently in the midst of a pandemic crisis. It is grappling with the spread of the COVID-19 across the country, a health service and nation under extreme pressure and the economic and social consequences of its emergency restrictions imposed on the population.

All national endeavour is focused on a strategy of containment and mitigation[15], otherwise known as a 'flattening the curve' – in order to prevent the National Health Service (NHS) from being overwhelmed by demand for its services, to reduce deaths and to slow down the epidemic.

As the peak of the epidemic nears, pressure is growing for the Government to explain its strategy for tackling COVID-19 once social distancing and isolation measures are relaxed. This third phase is often referred to as 'suppression' and in particular, of episodic outbreaks.[16]

Scientists advising the Government have warned that:

> "*Once interventions are relaxed, infections begin to rise, resulting in a predicted peak epidemic later in the year. The more successful a strategy is at temporary suppression, the larger the later epidemic is predicted to be in the absence of vaccination, due to lesser build-up of herd immunity*".[17]

If restrictions are lifted, in the absence of a vaccination or herd immunity, only two other viable tactical options for a strategy of 'suppression' remain: **Testing and Tracing.**

The same scientists advise that:

> "*As case numbers fall, it becomes more feasible to adopt intensive testing, contact tracing and quarantine measures akin to the strategies being employed in South Korea today. Technology – such as mobile phone App's that track an individual's interactions with other people in society – might allow such a policy to be more effective and scalable if the associated privacy concerns can be overcome*".[18]

This paper focuses solely on contact tracing. It assumes that the UK Government will be able to significantly upscale its swab testing regime (its 'Five Pillar' testing strategy) and explores how the data from testing should be fused with other digital tracing and tracking data acquired from new technologies such as smartphone Apps in order to understand the spread of COVID-19 and take operational action to eliminate it from the UK.

An ongoing suppression strategy involving testing and tracing is vitally important:

15. https://preventepidemics.org/coronavirus/insights/#adaptive-response-to-COVID-19
16. https://www.cnn.com/2020/03/20/health/coronavirus-response-must-adapt-frieden-analysis/index.html
17. https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf
18. https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf

'Epidemiological testing — where the contacts of infected people are identified, tested in turn and isolated as needed — is the only way to fully break the chains of transmission, says Adhanom Ghebreyesus Tedros, head of the W.H.O. Without it, the virus will come roaring back as soon as social distancing guidelines are relaxed'[19].

'Until a vaccine is ready — and that is another area where the state must spend billions and drastically upend the rules — the Government needs to pursue a three-pronged strategy to allow the reopening of the economy and society while simultaneously minimising deaths. There needs to be an unprecedented programme of testing, contact tracing and protection'[20].

There is a strong body of evidence emerging from around the world that supports a strategy of contact tracing alongside a comprehensive testing regime.

Commenting on the government's five pillar testing strategy, Prof Martin Hibberd from the London School of Hygiene and Tropical Medicine said:

"These five pillars will all need to be in place before we can start to lift the current social distancing requirements, so we hope they can be delivered soon. I would add that there is still one pillar missing — contact tracing, which would allow people to recognise when they have been in contact with a SARS-CoV-2 positive case and allow additional, targeted testing. This contact tracing could be done on a voluntary basis and huge developments in this field mean that there are now informative Apps for everyone's smart phones that can help with this"[21].

What is Contact Tracing?

Contact tracing[22] is a simple process based on the principal that:

'People in close contact with someone who is infected with a virus…are at higher risk of becoming infected themselves, and of potentially further infecting others. Closely watching these contacts after exposure to an infected person will help the contacts to get care and treatment and will prevent further transmission of the virus'.

The World Health Organisation (WHO) breaks this process down into three basic steps:

- **Contact identification** (once someone is confirmed as infected with a virus, contacts are identified by analysis of a person's activities since onset of the virus.)
- **Contact Listing** (all persons considered to have contact with the infected person should be listed as contacts and efforts made to inform them of their contact status, to provide them with information about prevention of the disease and recommend quarantine and self-isolation for high risk contacts, either at home or at a hospital.)

19. https://www.nytimes.com/2020/03/19/opinion/coronavirus-testing.html
20. https://www.telegraph.co.uk/politics/2020/03/25/test-test-test-save-theuk-pandemic-nightmare/
21. https://www.sciencemediacentre.org/expert-reaction-to-publication-of-detail-of-five-pillars-of-how-the-government-intends-to-scale-up-COVID-19-testing-programmes/
22. https://www.who.int/features/qa/contact-tracing/en/

- **Contact follow-up** (regular follow-up should be conducted with all contacts to monitor for symptoms and test for signs of infection.)

Traditionally, this process has been undertaken in various countries manually by teams of health care employees using fairly conventional methodologies such as the searching of open sources (e.g. internet) and some closed sources (such as flight manifests) and the visiting of individuals believed to have been infected or been in the presence of someone infected.

Countries that have previously experienced severe epidemics of new diseases such as SARS, MERS or Ebola have developed far more expertise in contact tracing than countries less affected by these outbreaks. Asian economies such as China, South Korea and Singapore have also devised more sophisticated technological solutions, including the use of smartphone Apps and Big Data analysis.

Successful contact tracing (shown in Figure 1.0 below) depends on the speed of the response broken down as follows:

- how quickly a person first reports their symptoms to authorities;
- the speed at which the authorities undertake a swab test and get the results back
- how quickly authorities then 'trace' those that the infected person has been in contact with within a defined period of time

Figure 1.0 – Graphic showing the process of contact tracing

Source : https://science.sciencemag.org/content/early/2020/04/09/science.abb6936.full
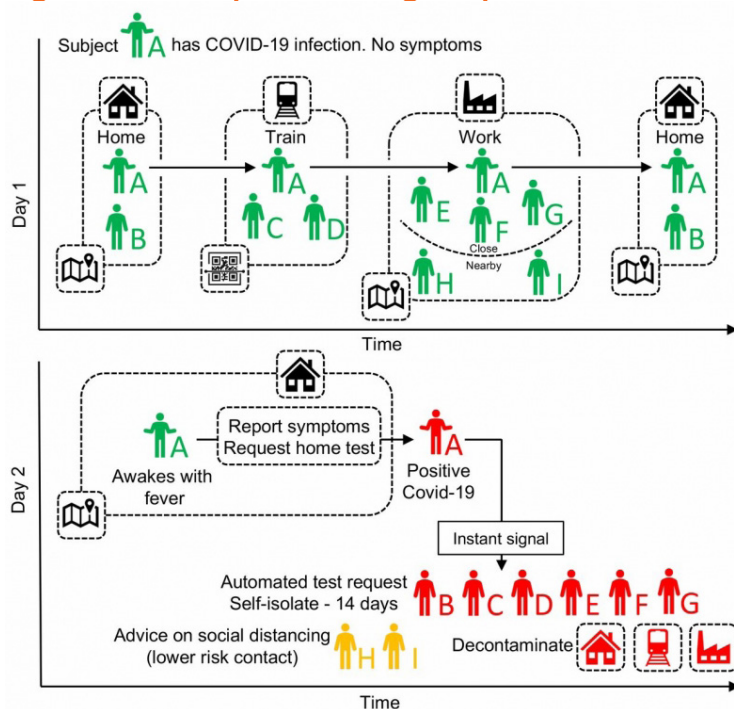
The inadequacy of manual contact tracing

United Kingdom

Public Health England (PHE) describes 'contact tracing' as:

> *'a fundamental part of outbreak control that's used by public health professionals around the world. If a person tests positive for novel coronavirus, we speak to the patient to identify anyone who has had close contact with them during the time they are considered to be infectious and go all out to find these people as soon as possible. Once we have made contact with them we can then give them the advice they need. If they are in groups considered to be a higher risk, we make sure that we follow up with them on a daily basis to see how they are. If they become unwell we are then able to assess them quickly and take Appropriate action'*[23].

In the UK, this role is carried out by nine regional centres staffed by PHE teams consisting of specialists in microbiology, epidemiology, and intelligence teams who provide specialist surveillance and intelligence for localities.

PHE has experience of dealing with outbreaks of respiratory diseases such as coronavirus. Most recently, fast contact tracing action taken in August 2018 prevented an outbreak of Middle East Respiratory Syndrome (a respiratory illness caused by the MERS coronavirus (MERS- Cov)) after PHE confirmed a case in Leeds of an individual who had flown to the UK from the Middle East[24]. Whilst not as contagious as other viruses such as influenza, 40% of people who get MERS die of complications.

In this case, PHE traced three key groups of contacts including:

- the individual's family;
- passengers on the plane who were in very close proximity to the individual;
- healthcare workers who had been in contact with the patient (including before MERS was suspected).

PHE report that the response involved over 100 people as well as many staff in the NHS who prevented onward transmission of the disease[25].

Success in the MERS case was not matched by the same level of success in contact tracing those transmitting COVID-19, a virus that is more highly infectious with a consequential faster rate of spread. Compared

23. https://publichealthmatters.blog.gov.uk/2020/02/13/expert-interview-what-is-contact-tracing/
24. https://publichealthmatters.blog.gov.uk/2019/06/06/disease-detectives-how-a-case-of-mers-in-england-was-detected-traced-and-treated/
25. https://publichealthmatters.blog.gov.uk/2019/06/06/disease-detectives-how-a-case-of-mers-in-england-was-detected-traced-and-treated/

to the intrusive digital surveillance measures that were undertaken in other countries more experienced in contact tracing, the UK response was limited and non-technological.

This was recently confirmed by Professor Neil Ferguson whose team from Imperial College London have been advising the government:

> 'Prof Ferguson estimated that in the early stages of the outbreak, Public Health England (PHE) had only managed to trace and isolate one third of people coming into the country with the virus, which seeded the epidemic.
>
> But speaking on Radio 4 over the weekend, he said he was "hopeful" that some of the intense social distancing measures could be substituted with rapid access to testing and contact tracing in a few weeks' time - once case numbers are lower'[26].

France

France was similarly challenged and exposed by the speed of spread of COVID-19. A single international church event in Mulhouse on Feb 18, a city of 100,000 on the border with Germany and Switzerland, led to 2,500 confirmed cases and the biggest cluster of cases in the entire country. The response by public health professionals was thorough but un-technological:

> 'The day after the first case linked to the church was identified on Feb. 29, public health officials followed the usual protocol and traced the people whom the carriers had been in contact with, to stem the spread. Using a list supplied by the church - which public health officials said cooperated fully - they first contacted those who had staffed the children's creche during the gathering.
>
> At this point, the health inspectors realized they were too late. Some creche staff were already sick, according to Michel Vernay, an epidemiologist with France's national public health agency in eastern France.
>
> We were overwhelmed," said Vernay. "We realized that we had a time bomb in front of us."[27].

During this period of manual contact tracing, worshippers at the church returned home to their home countries including Burkina Faso, Corsica, Guyana Switzerland spreading the virus internationally. By March 11, the WHO recorded 1,774 cases of COVID-19 in France of whom 33 had died (compared to 91 on March 3rd).

These UK and French case studies demonstrate the speed of the spread of the COVID-19 and the inadequacies of undertaking manual contact tracing in order to curtail its spread. The spread of infection simply cannot be tracked quickly enough using traditional manual techniques.

26. https://www.telegraph.co.uk/news/2020/04/05/revealed-coronavirus-exit-strategy-mass-testing-contact-tracing/
27. https://www.haaretz.com/science-and-health/coronavirus-spread-europe-church-1.8723559

Suppressing epidemics with digital contact tracing

If governments are to be more successful containing COVID-19 in the future, a different strategy for contact tracing is needed, one that will need to rely upon new technologies, a point now belatedly understood by many European governments as well as the USA.

Epidemiologists have been using smartphone data to defeat epidemics for over a decade, for instance, to track travel patterns across West Africa during the Ebola epidemic. In this case, epidemiologists worked with a Not for Profit organisation to analyse date from Senegal and Ivory Coast provided by Orange Telecom, a West African mobile phone carrier[28].

The recent outbreak of COVID-19 has exposed the limitations of the traditional contact tracing methodology, an appreciation that the leaders of some Asian economies already understood following their handling of previous pandemics:

> '*The first countries to realise they had to prepare for pandemics were the newly developed Asian economies, after they were hammered by Sars in 2003, Swine flu in 2009-2010 and Mers in 2015. As a result, Singapore and South Korea in particular have been remarkably efficient at containing the coronavirus*[29]

These countries have been developing technological solutions for contact tracing for some time and now appear to be significantly more successful than their western counterparts who are grappling to catch up and also wary of the ethical and legal considerations of surveilling their populations:

> '*The "technology to the rescue" idea has been gaining steam as the coronavirus pandemic has outpaced everything Europe and the U.S. have thrown at it, and not because of a deluded belief that digital tech can solve all the world's woes. Instead, this fix is aimed at a very specific problem: identifying cases of Covid-19 and quickly tracing everyone who came into contact with them before they infect others. That has helped countries such as South Korea, Taiwan, and Singapore beat back the epidemic, though sometimes through measures that trample privacy*'[30].

Professor Raskar of the Massachusetts Institute of Technology describes the process of contact tracing as follows:

> "*Epidemics is a game of probabilities, not a game of absolutes. You don't have to catch everyone. If you trace even a small fraction of people, that will start reducing the R_0, which is the average number of people who are infected by a patient*"[31].

28. https://www.hsph.harvard.edu/news/hsph-in-the-news/predicting-ebolas-spread-using-cell-phone-data/
29. https://www.telegraph.co.uk/politics/2020/03/25/test-test-test-save-theuk-pandemic-nightmare/
30. https://www.statnews.com/2020/04/02/coronavirus-spreads-too-fast-for-contact-tracing-digital-tools-could-help/
31. https://spectrum.ieee.org/the-human-os/biomedical/ethics/halting-covid19-benefits-risks-digital-contact-tracing

and digital contact tracing as:

> "a way to figure out if two people were in the same location at the same time, based on co-location tracking. The simplest scenario, and the one we're deploying, is that everyone downloads an App with a GPS-based location logger. When a person is confirmed as having COVID-19, they donate their GPS data to the App's server. This gives a location trail of everywhere they've been for the last two weeks, but without revealing the person's identity. Everyone else who uses the App can look at those trails to compare with their own to see if there was significant overlap, but they never have to share their trails".

Academics and epidemiologists have been researching using mobile phone data to assist with understanding the spread of epidemics for some time:

> "Seminal work on human mobility has shown that mobile phone data can assist the modelling of the geographical spread of epidemics. Thus, researchers and governments have started to collaborate with private companies, most notably mobile network operators, to estimate and visualize the effectiveness of control measures"[32][33]."

Research shows that:

> "the use of mobile phone data can offer a 'critical contribution to four broad areas of investigations: **Situational awareness** (to better understand trends and geographical distribution), **Cause and effect** (identifying key drivers and consequences of implementing different measures to contain the spread of COVID-19), **Prediction** (to enable new predictive capabilities and allow stakeholders to assess future risks, needs and opportunities), **Impact assessment** (to identify obstacles hampering the achievement of certain objectives or the success of particular interventions)[34]."

Recent research by Oxford University has also provided a strong evidence base for digital contact tracing to assist in suppressing the COVID-19:

> "that viral spread is too fast to be contained by manual contact tracing, but could be controlled if this process was faster, more efficient and happened at scale. A contact-tracing App which builds memory of proximity contacts and immediately notifies contacts of positive cases can achieve epidemic control if used by enough people. By targeting recommendations to only those at risk. Epidemics could be contained without need for mass quarantines ('lock-downs') that are harmful to society.'[35]

The practice of using digital contact tracing against COVID-19 introduces legal and ethical dimensions that need to be considered and which are explored in this paper.

32. Bengtsson, L., Gaudart, J., Lu, X., Moore, S., Wetter, E., Sallah, K., Rebaudet, S., and Piarroux, P. (2015). Using mobile phone data to predict the spatial spread of cholera. Scientific Reports, 5, 8923, https://doi.org/10.1038/srep08923

33. Wesolowski, A., Eagle, N., Tatem, AJ., Smith, DL., Noor, AM., Snow, RW., Buckee, CO. (2012). Quantifying the impact of human mobility on malaria. Science, 338 (6104): 267-270, https://doi.org/10.1126/science.1223467

34. 'Mobile phone data and COVID-19: Missing an opportunity?', 26 March 2020;

Nuria Oliver, Emmanuel Letouzé,, Harald Sterly, Sébastien Delataille5, Marco De Nadai6, Bruno Lepri, Renaud Lambiotte, Richard Benjamins, Ciro Cattuto, Vittoria Colizza, Nicolas de Cordes, Samuel P. Fraiberger, Till Koebe, Sune Lehman, Juan Murillo, Alex Pentland, Phuong N Pham, Frédéric Pivetta, Albert Ali Salah, Jari Saramäki, Samuel V. Scarpino, Michele Tizzoni, Stefaan Verhulst, Patrick Vinck,

35. https://science.sciencemag.org/content/early/2020/03/30/science.abb6936

Case studies

China and digital contact tracing

China has been using a digital App described as 'voluntary', as part of its public health policy to combat the COVID-19 since early February 2020. The system was first introduced in the eastern city of Hangzhou as China encouraged people to return to work during the coronavirus outbreak but is now reportedly in use across 200 cities and is being rolled out nationwide.

The Oxford University study describes how it is currently been used:

> *"The App allows a central database to collect data on user movement and coronavirus diagnosis and displays a green, amber or red code to relax or enforce restrictions on movement. The database is reported to be analysed by an artificial intelligence algorithm that issues the colour codes"*[36].

The App is called **'Health Code'** and is run by the Chinese Government with individuals being able to sign up through a wallet App called 'Alipay' run by the tech firm Tencent.

It has been reported that:

> *"More than a billion people use Tencent's Apps in China, while over 900 million Chinese citizens use Alipay. Over 700 million people have started using Tencent's* **Health Code** *service"*

And that:

> *"Visitors to office buildings, shopping malls, residential compounds and metro systems are now being asked to scan QR codes using their mobile phones and fill in forms asking for information such as their travel history and body temperature, according to residents and local media reports".*

Concerns have been expressed that the App appears to send personal data to police, setting a concerning precedent for state surveillance and control[37].

The New York Times:

> *"studied the code of the App and found that it sends a person's location, city name, and an identifying code number to a server that supposedly belongs to authorities. The App shares this data to the server every time someone scans the code. This makes it easier for the authorities to track someone's movements. While it's common for tech companies in China to share the data with the government, this direct method sets a new precedent"*[38].

Tencent have defended the App from allegations that it intrudes on the privacy of users:

36. https://science.sciencemag.org/content/early/2020/03/30/science.abb6936

37. https://www.nytimes.com/2020/03/01/business/china-coronavirus-surveillance.html

38. https://thenextweb.com/china/2020/03/03/chinas-COVID-19-App-reportedly-color-codes-people-and-shares-data-with-cops/

"Tencent said none of its efforts to fight the virus involved the real-time tracking of people or virus movements.

"Third-party developers, such as those who offer health code services via WeChat Mini Programs, are required to adhere to the platform's data security requirements and anonymised user data was only accessible by the mini program's developer, Tencent said"[39].

Chinese Government officials have also defended allegations of intrusions of privacy:

"Liu Yuewen, who heads Yunnan province's department of public security's big data expert group, said individuals' privacy would be protected, and the data would be destroyed when efforts to control the epidemic end."

"No one will be able to see any data without the permission of the epidemic prevention and control headquarters," he said, according to a report by the state-backed Beijing News." [40]

South Korea digital contact tracing

According to Professor Gye Cheol Kwon, the chairman of the Laboratory Medicine Foundation, South Korea:

"learned the risk of new infection and its ramifications from the experience of the Middle East Respiratory syndrome (MERS) back in 2015,"

"It forced the country to reassess its approach to infectious diseases. South Korea's Centres for Disease Control even set up a special department to prepare for the worst. In this case, that preparation appears to have paid off"[41].

"Every region that has managed to get a coronavirus outbreak under control has succeeded thanks to a combination of social distancing and aggressive efforts to test as many people as possible. South Korea, for example, has tested some 274,000 people since February. The United States has tested just 82,000 people, the vast majority of them in the past few weeks."[42]

And the South Korean Government now routinely uses digital contact tracing to:

"send alerts flashing on smartphone screens updating the public on new infections in their area as well as health office twice daily broadcasting updating containment efforts. The focus on open communication, coupled with an online system to track those people who have been infected, has helped limit the spread of the virus."[43]

Anne Liu, a global health expert at Columbia University has warned, however, that the Korean approach risks unmasking and stigmatising infected people and the businesses they frequent:

"South Korea has released detailed information on infected individuals—

39. https://www.reuters.com/article/us-china-health-data-collection/china-rolls-out-fresh-data-collection-campaign-to-combat-coronavirus-idUSKCN20K0LW
40. https://www.reuters.com/article/us-china-health-data-collection/china-rolls-out-fresh-data-collection-campaign-to-combat-coronavirus-idUSKCN20K0LW
41. https://www.bbc.co.uk/news/world-asia-51836898
42. https://www.nytimes.com/2020/03/19/opinion/coronavirus-testing.html
43. https://www.ft.com/content/e015e096-6532-11ea-a6cd-df28cc3c6a68

including their recent movements—viewable through multiple private *App's* that send alerts to users in their vicinity. *"They're essentially texting people, saying, 'Hey, there's been a 60-year-old woman who's positive for COVID. Click this for more information about her pathath,'""*.[44]

Taiwan

Taiwan has proven to be one of the best prepared nations in the world as with regards to their response to the Covid-19 epidemic.

The reason for this is explained by the Taiwan Centres for Disease Control:

> 'In 2003, the global epidemic SARS relentlessly tested Taiwan's capability for public health emergency management. There was an urgent need for a disaster management centre that focused on large outbreak responses and act as the operational command point for direct communications among the central, regional and local authorities. In response, with the CDC as the base, the Government established the National Health Command Center (NHCC) in 2004. There was also a global trend to establish such a command center in response to public health emergencies'[45].

The National Health Command Center (NHCC) addresses public health emergency and provides disaster information for decision-makers. It is a unified central command system that includes the Central Epidemic Command Center, the Biological Pathogen Disaster Command Center, the Counter-Bioterrorism Command Center and the Central Medical Emergency Operations Center. This joint framework serves as a comprehensive platform for preventing major epidemics[46].

Taiwan has also:

> *"deployed a combination of big data, transparency and central command"*[47]

> *"…made use of technology, integrating the national health insurance database with its immigration and customs database. By merging databases, they could collect information on every citizen's 14-day travel history and ask those who visited high-risk areas to self-isolate. Mobile phones were tracked to ensure people stayed at home. Those who had not been to a high-risk area received a SMS to enable faster immigration clearance when traveling"*

The Central Epidemic Command Centre also:

> 'serves as a coordinator of all epidemic responses and updates the public about COVID-19'[48]

Commenting on Taiwan's capabilities to combat the outbreak Prof. Jason Wang, an associate professor of paediatrics at Stanford Medicine in California said:

> *"The establishment of the national health command centre was really critical. It's like a little compound where all the information comes from local and*

44. https://www.sciencemag.org/news/2020/03/cellphone-tracking-could-help-stem-spread-coronavirus-privacy-price
45. https://www.cdc.gov.tw/En/Category/MPage/gL7-bARtHyNdrDq882pJ9Q
46. https://www.cdc.gov.tw/En/Category/MPage/gL7-bARtHyNdrDq882pJ9Q
47. https://time.com/5805629/coronavirus-taiwan/
48. https://focustaiwan.tw/society/202003160019

central Government and it all gets integrated. You get the data, process it and then you can tell people what's going on[49]."

Taiwan's 'digital fence'

Taiwan has also introduced a monitoring system it calls a "digital fence' whereby:

> *"anyone required to undergo home quarantine has their location monitored via cellular signals from their phones. Venturing too far from homes triggers the alert system, and calls and messages are sent to the confine to ascertain their whereabouts. Anyone caught breaching their quarantine can be fined up to NT$1million ($33,000)."[50]*

> *"The goal is to stop people from running around and spreading the infection,"*

said Jyan Hong-wei, head of Taiwan's Department of Cyber Security, who leads efforts to work with telecom carriers to combat the virus[51].

Singapore

The BBC correspondent Karishma Vaswani describes in 'Singapore's virus detectives' how Singapore undertakes its contact tracing:

> *"A British yoga teacher was called from an unknown number: "Were you in a taxi at 0847hrs on Wednesday?" She had just been 'contact traced' and told to stay at home. Three officers from the Ministry of Health, complete with surgical masks and gloves, turned up on her doorstep the next day to issue her with a "quarantine order" with a threat of a prison sentence or fine for non-compliance.*

> *"The 'contact tracing' team undertake an extensive 'activity map' for each 'contact' for the last 7 days of personal movement prior to signs of infection. They list everyone she has met using phone data. This data is then passed to the Singapore Government which arranges for all the people deemed to be at risk to be contacted – i.e. those who have spent 30 mins or more in under 2 metres away from the person".[52]*

A YouTube film by The Straits Times entitled "Coronavirus: How contact tracing tracks down people at risk of infection" [53]explains how Singapore's contact tracing methodology is applied in practice**.**

Singapore launches TraceTogether App

Singapore launched a new mobile phone application 'TraceTogether'[54] on March 20th to support on-going contact tracing in relation to the spread of the COVID-19.

The voluntary App developed by the Singapore Government encourages users to "help" in the contact tracing process and can be downloaded by anyone using a Singapore mobile number and a Bluetooth enabled smartphone.

Channel NewsAsia describes how the App works:

49. https://www.telegraph.co.uk/news/2020/03/06/taiwan-sets-gold-standard-epidemic-response-keep-infection-rates/
50. https://qz.com/1825997/taiwan-phone-tracking-system-monitors-55000-under-coronavirus-quarantine/
51. https://www.reuters.com/article/us-health-coronavirus-taiwan-surveillanc/taiwans-new-electronic-fence-for-quarantines-leads-wave-of-virus-monitoring-idUSKBN2170SK
52. 'Radio 4 'From our own correspondent: 'Singapore's Virus Detectives', Krishna Vaswani. https://www.bbc.co.uk/programmes/m000gt1s
53. https://www.youtube.com/watch?v=ez1p-oNReLLA
54. https://www.tracetogether.gov.sg

"The *App* works by exchanging short-distance Bluetooth signals between phones to detect other users of the *App* who are in close proximity. Current MOH guidelines define close proximity as two metres apart, or up to five metres, for 30 minutes.

Records of these encounters will be stored locally in the users' phones and will not be sent to the authorities.

Users will only be asked to share these records when contacted by MOH as part of contact tracing investigations. If they refuse, they may be prosecuted under the *Infectious Diseases Act*.

The new *App* will not replace ongoing contact tracing efforts, but it will facilitate the process, enabling contact tracers to inform users who are close contacts of COVID-19 cases 'more quickly'."

In relation to privacy:

"The authorities stressed that the use of the *App* is voluntary and that users have to give "explicit consent" to participate in TraceTogether.

This consent can be withdrawn anytime, according to GovTech.

The *App* also has several layers of security and privacy safeguards in place. For example, users will submit only their mobile numbers after downloading the *App* Each phone will then be assigned a user ID.

This user ID is then used to generate temporary IDs at regular intervals. It is this temporary ID that is exchanged between the phones of TraceTogether users.

Such regular generation of temporary IDs protect users from eavesdropping and tracking overtime by malicious actors, according to GovTech.

No other personal detail, such as names, will be collected. Neither does the *App* access a user's phone contact list or address book.

The *App* also does not collect or use location data of any kind, such as GPS.

"The *App* doesn't identify 'where' the exposure to COVID-19 cases may have occurred. It only seeks to establish 'who' else might have been exposed to the virus," according to the TraceTogether website.

This means that location information can only be established by contact tracers during verbal interviews, it added.

All TraceTogether logs will be stored locally on the users' phone in an encrypted form.

"The logs do not contain the user's phone numbers but a set of cryptographically generated temporary IDs," the joint press release said.

"The logs leave his or her phone only when he or she uses the App to send the information to authorities to facilitate contact tracing," it added.

Even then, the authorities, including MOH and GovTech, have no knowledge of the user's data as these logs are only deciphered and analysed after the user sends the information.

Other safeguards include how the App will only be active during disease outbreaks. For instance, after contact tracing ceases, the App will prompt users to deactivate its functionality"[55].

European contact tracing App initiatives

A Swiss not for profit consortium of European tech companies is developing a mobile phone application similar to TraceTogether in Singapore. It was created to provide:

"a solution to this crisis that adheres to strong European privacy and data protection laws and principles. The PEPP-PT technical mechanism and standards fully protect privacy whilst taking advantage of the possibilities of digital technology to maximise the speed and real-time capability of national pandemic responses. Our goal is to make this technology available to all countries, managers of infectious disease responses and developers as quickly and seamlessly as possible.

The PEPP-PT team, which as of 31ˢᵗ March has more than 130 members across 8 European countries includes scientists, technologists and experts from well-known international research institutions and companies.

These will become more important in containing future flare-ups in COVID-19, the flu-like illness caused by coronavirus, once country-wide lockdowns have succeeded in 'flattening' the curve of the pandemic's spread".[56]

PEPP-PT states its aims to be to:

"make it possible to interrupt new chains of SARS-CoV-2 transmission rapidly and effectively by informing potentially exposed people".[57]

Several European countries are independently developing or intending to develop a smartphone App to assist with contact tracing. For example, the Polish Government has launched a voluntary smartphone App called "**Home Quarantine**" for their own nationals returning back to Poland from abroad who are required at the moment to self-isolate for two weeks:

"To register, they upload personal details and a photo. They are then sent reminders via text message and should respond within 20 minutes by uploading a new selfie. This is verified by facial recognition and its location stamp is checked against the registered address"[58].

Germany intends to release a smartphone App called **GeoHealth** soon. This App:

55. https://www.channelnewsasia.com/news/singapore/covid19-trace-together-mobile-App-contact-tracing-coronavirus-12560616
56. https://uk.reuters.com/article/uk-health-coronavirus-europe-tech/europe-to-launch-coronavirus-contact-tracing-App-initiative-idUKKBN21J4GP
57. https://www.pepp-pt.org
58. https://www.reuters.com/article/us-health-coronavirus-europe-tech-poland/in-europe-tech-battle-against-coronavirus-clashes-with-privacy-culture-idUSKBN21D1CC

"relies partly on location data that Google already stores for its account holders. A person who tests positive could use the App—called GeoHealth—to "donate" their location history. That data would then be anonymized and stored on a central server, says Gernot Beutel, a stem cell transplant physician at Hannover Medical School who is co-developing the technology. A data analytics platform designed by the software company Ubilabs would compare users' movement history to that of infected people, and the App would show them color-coded alerts based on how recently they may have encountered the virus. Though a combination of GPS tracking, wireless network data, and connections between phones via Bluetooth, Beutel says the App should be able to detect when a phone comes within 1 meter of another phone"[59].

UK technology solutions to assist contact tracing

The Secretary of State for the Department of Health and Social Care Matt Hancock confirmed on 12th April 2020 the UK Government's intention to release a voluntary digital contact tracing App:

"If you become unwell with the symptoms of coronavirus, you can securely tell this new NHS App" he explained.

"And the App will then send an alert anonymously to other App users that you've been in significant contact with over the past few days, even before you had symptoms, so that they know and can act accordingly.

"All data will be handled according to the highest ethical and security standards and would only be used for NHS care and research.

"And we won't hold it any longer than is needed."[60]

The work is being led by NHSX[61], the NHS's digital board that:

"brings teams together from the Department of Health and Social Care, NHS England and NHS Improvement together into one unit to drive digital transformation and lead policy, implementation and change"[62]

Matthew Gould, Chief Executive of NHSX, said :

"NHSX are looking at whether App based solutions might be helpful in tracking and managing coronavirus, and we have assembled expertise from inside and outside the organisation to do this as rapidly as possible."[63]

The Health Service Journal (HSJ) stated that:

"The contact tracking App which will operate on an opt-in basis, will be released either just before or just after the lockdown is lifted, according to several people with close knowledge of the project.

NHS bosses hope the App will attract more than 50% of the population, as large numbers of people using it together will be necessary for it to work effectively[64].

The App will detect other phones in close vicinity using short-range Bluetooth

59. https://www.sciencemag.org/news/2020/03/cellphone-tracking-could-help-stem-spread-coronavirus-privacy-price
60. https://www.bbc.com/news/technology-52263244
61. https://www.nhsx.nhs.uk
62. https://www.nhsx.nhs.uk/who-we-are
63. https://www.hsj.co.uk/free-for-non-subscribers/nhs-developing-coronavirus-contact-tracking-App./7027163.article
64. https://news.sky.com/story/coronavirus-govt-set-to-release-contact-tracking-App.-which-detects-nearby-virus-carriers-11966243

signals, then store a record of those contacts on the device, the sources say.

This method means data is not sent regularly to a central authority, potentially easing concerns around privacy, which NHSX fears may slow adoption of the App.[65].

HSJ also stated that NHS Digital (which exists to harness the power and technology to improve health and care[66]) is developing an "algorithm" (measuring amongst other factors, clinical and prescribing history) that will:

"identify patients who are most at risk of developing complications from coronavirus."

"We are delivering changes to summary care records, so there are two new flags going on the summary care record. One that will track whether someone is [Covid-19] positive should that data be available, and one that will track whether someone is in the vulnerable category, should that be available."

"Letters will then be sent to those identified informing them how they can access healthcare if they need it and how to care for themselves'"[67].

Work by NHS England and Improvement is also on-going to create:

"a data store to bring multiple data sources into a single, secure location. This is what we are calling the backend or initial store. Data needed to inform the Covid-19 response will come from across the NHS and social care and from partner organisations. It will include data such as 111 online/call centre data from NHS Digital and Covid-19 test result data from Public Health England".[67]

The NHS has been explicit that all data will remain under NHS England and NHS Improvement's control and that retention will be time limited:

"Once the public health emergency situation has ended, data will either be destroyed or returned in line with the law and the strict contractual agreements that are in place between the NHS and partners"[68]

"A beta form of our first dashboard will be ready to share with key Government decision-makers this week, with the intention to make as much data openly available as possible over time, including a separate dashboard to support public understanding. We will make the code and the data open source wherever we can while ensuring the highest standards of confidentiality".

It is important to note that the UK does not have a national identification scheme in place, unlike many other countries that are considering or already developing digital Apps to assist contact tracing. For those countries with an identification scheme, using a "unique identifier" for every citizen will assist with linking different data sets together, including, for instance, health records. Whilst every UK citizen has an NHS unique number linking them to their health records, importantly, there is no

65. https://news.sky.com/story/coronavirus-govt-set-to-release-contact-tracking-App.-which-detects-nearby-virus-carriers-11966243
66. https://digital.nhs.uk/about-nhs-digital
67. https://healthtech.blog.gov.uk/2020/03/28/the-power-of-data-in-a-pandemic/
68. https://healthtech.blog.gov.uk/2020/03/28/the-power-of-data-in-a-pandemic/

national identification scheme linking these records to other documents such as passports.

In future, digital identification could help with the issuing of immunity certificates that could be used by the UK Government to allow those who have had COVID-19 to be freed from emergency restrictions because they have developed immunity to it.[69] The Secretary of State for Health and Social Care, Matt Hancock, has already alluded to immunity certificates in briefings given by the Government[70] and many countries are exploring whether it is appropriate to use them, including the USA[71] and Germany[72].

The role of state intelligence agencies in digital contact tracing

Israel

The Israeli Government approved emergency measures for its security agencies to track the mobile phone data of people with suspected COVID-19:

> Details of how the "cyber-monitoring" will work were not disclosed but it is understood the location data collected through telecommunication companies by Shin Bet, the domestic security agency, will be shared with health officials[73].

> The idea is to sift through geolocation data routinely collected from Israeli cellphone providers about millions of their customers in Israel and the West Bank, find people who came into close contact with known virus carriers and send them text messages directing them to isolate themselves immediately[74].

> Anticipating such criticism, officials insisted that the use of cellphone data by the Internal Security Agency — known by its Hebrew acronym, Shin Bet — would be scrupulously circumscribed.

> "The use of advanced Shin Bet technologies is intended for one purpose only: saving lives," said a senior security official, who insisted on anonymity to discuss such a sensitive matter. "In this way, the spread of the virus in Israel can be narrowed, quickly and efficiently. This is a focused, time-limited and limited activity that is monitored by the government, the attorney general and the Knesset's regulatory mechanisms".

> "Two laws and a number of secret regulations and administrative orders govern the data-collection effort and its use by the Shin Bet, officials said.

> The Telecommunications Law, amended in 1995 with the advent of widespread cellular networks, gives the prime minister broad powers to order carriers to allow access to their facilities and databases "as necessary to perform the functions of the security forces or to exercise their powers."

> Article 11 of the Israeli Security Agency Law, enacted in 2002, lets the prime minister determine what sort of information about cellphone subscribers "is required by the service to fulfil its purpose," and declares that the companies

69. https://news.sky.com/story/coronavirus-could-biometric-id-cards-offer-the-uk-a-lockdown-exit-strategy-11970628
70. https://news.sky.com/story/coronavirus-could-biometric-id-cards-offer-the-uk-a-lockdown-exit-strategy-11970628
71. https://www.politico.com/news/2020/04/10/fauci-coronavirus-immunity-cards-for-americans-are-being-discussed-178784
72. https://www.businessinsider.com/coronavirus-germany-COVID-19-immunity-certificates-testing-social-distancing-lockdown-2020-3
73. https://www.bbc.co.uk/news/technology-51930681
74. https://bdnews24.com/world/middle-east/2020/03/17/to-track-coronavirus-israel-moves-to-tap-secret-trove-of-cellphone-data

must "*transfer information of these types*" to the Shin Bet.

Under that law, it is up to the head of the Shin Bet to determine how cellphone data is used. While the law authorises its use for only six months, the Shin Bet director may reauthorise it. The director is required to report to the attorney general every three months and to the Knesset's Secret Services Subcommittee yearly.

Using cellphone data to combat the coronavirus requires Government approval because the Security Agency Law limits the Shin Bet's role to protecting Israel "against threats of terror, sabotage, subversion, espionage and exposure of state secrets." It is permitted to act in other ways "vital to national security" but only with the approval of the cabinet and the Secret Services Subcommittee[75].

In a statement posted on Facebook, Prime Minister Benjamin Netanyahu wrote:

"We will dramatically increase the ability to locate and quarantine those who have been infected. Today, we started using digital technology to locate people who have been in contact with those stricken by the Corona. We will inform these people that they must go into quarantine for 14 days. These are expected to be large – even very large – numbers and we will announce this in the coming days. Going into quarantine will not be a recommendation but a requirement and we will enforce it without compromise. This is a critical step in slowing the spread of the epidemic".[76]

The Israeli Health Ministry launched the government's smartphone digital App '**HaMagen**' (The Shield) on 23rd March. The App reveals if a user was in close proximity to anyone who has been diagnosed with the virus in the past 14 days.

"After a user installs the App it keeps track of their movements and compares the information with Health Ministry data on where those who are positively diagnosed have been. If the App finds a match — that the user was in the same area at the same time — it links the smartphone's owner to the Health Ministry website for information on what to do next, and how to register as going into self-quarantine.

The ministry stressed that all the information on the user's movements is only stored on the smartphone, which is kept updated by the ministry with the epidemiological data of known COVID-19 cases"[77].

It has been reported that around 1.5 million Israelis have already downloaded the mobile App and that in the first week 50,000 App users reported that they had self-quarantined[78].

75. https://bdnews24.com/world/middle-east/2020/03/17/to-track-coronavirus-israel-moves-to-tap-secret-trove-of-cellphone-data
76. https://www.facebook.com/IsraeliPM/posts/3345468375467884
77. https://www.timesofisrael.com/health-ministry-launches-phone-App-to-help-prevent-spread-of-coronavirus/
78. https://www.reuters.com/article/us-health-coronavirus-israel-App's/1-5-million-israelis-using-voluntary-coronavirus-monitoring-App-idUSKBN21J5L5

Private sector technology companies and digital contact tracing

Technology companies across the world have been exploring ways of using technology to assist combating the COVID-19:

Apple released a screening App on 27th March 2020 and describes its utility as to:

> "help people stay informed and take the proper steps to protect their health during the spread of COVID-19, based on the latest Centre for Disease Control (CDC) guidance. The new COVID-19 websites and COVID-19 App available on the App Store, were created in partnership with the CDC,[1] the White House Coronavirus Task Force and FEMA to make it easy for people across the country to get trusted information and guidance at a time when the US is feeling the heavy burden of COVID-19.
>
> The COVID-19 App and website allow users to answer a series of questions around risk factors, recent exposure and symptoms for themselves or a loved one. In turn, they will receive CDC recommendations on next steps, including guidance on social distancing and self-isolating, how to closely monitor symptoms, whether or not a test is recommended at this time, and when to contact a medical provider. This new screening tool is designed to be a resource for individuals and does not replace instructions from healthcare providers or guidance from state and local health authorities"[79].

Apple reports addresses privacy on its website:

> "Apple is not collecting your answers from the screening tool…To help improve the site, Apple collects some information about how you use it. The information collected will not personally identify you."

But four U.S. Democratic Senators are asking questions relating to privacy:

> "While we acknowledge Apple's statements regarding user privacy and that the questionnaire tools 'do not require a sign-in or association with a user's Apple ID, and users' individual responses will not be sent to Apple or any Government organization, we are nonetheless concerned for the safety and security of Americans' private health data,"[80]

Following requests by the US Government, Google has been:

79. https://www.Apple.com/news-room/2020/03/Apple-releases-new-COVID-19-App-and-website-based-on-CDC-guidance/

80. https://www.cnbc.com/2020/04/03/senators-ask-Apple-ceo-about-the-companys-COVID-19-App-privacy-practices.html

"exploring ways that aggregated anonymized location information could help in the fight against COVID-19 … and the project would follow our stringent privacy protocols and would not involve sharing data about any individual's location, movement, or contacts,"[81]

On 3 April, Google launched its COVID-19 Community Mobility Reports. It describes the utility of this data as follows:

"As global communities respond to COVID-19, we've heard from public health officials that the same type of aggregated, anonymized insights we use in products such as Google Maps could be helpful as they make critical decisions to combat COVID-19.

These Community Mobility Reports aim to provide insights into what has changed in response to policies aimed at combating COVID-19. The reports chart movement trends over time by geography, across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential"[82].

Google asserts that all the data is anonymised:

"For these reports, we use differential privacy, which adds artificial noise to our datasets enabling high quality results without identifying any individual person," Google writes. *"The insights are created with aggregated, anonymized sets of data from users who have turned on the Location History setting, which is off by default."*[83]

On 10th April, Apple and Google issued a joint statement announcing that both companies will be:

"launching a comprehensive solution that includes Application Programming Interfaces (APIs) and operating system-level technology to assist in enabling contact tracing. Given the urgent need, the plan is to implement this solution in two steps while maintaining strong protections around user privacy.

First, in May, both companies will release APIs that enable interoperability between Android and iOS devices using App's from public health authorities. These official App's will be available for users to download via their respective App stores.

Second, in the coming months, Apple and Google will work to enable a broader Bluetooth-based contact tracing platform by building this functionality into the underlying platforms. This is a more robust solution than an API and would allow more individuals to participate, if they choose to opt in, as well as enable interaction with a broader ecosystem of App's and Government health authorities. Privacy, transparency, and consent are of utmost importance in this effort, and we look forward to building this functionality in consultation with interested stakeholders. We will openly publish information about our work for others to analyse"[84].

The first solution proposed will assist the creation of Apps being developed

81. https://www.politico.com/news/2020/03/18/big-tech-coronavirus-134523
82. https://www.google.com/covid19/mobility/
83. https://techcrunch.com/2020/04/03/google-is-now-publishing-coronavirus-mobility-reports-feeding-off-users-location-history/
84. https://www.Apple.com/newsroom/2020/04/Apple-and-google-partner-on-COVID-19-contact-tracing-technology/

by governments of different nation states in the short term. The second development (building the contact tracing system into the operating system of the phone) will ensure that data epidemiologists and contact tracers only access anonymised data that they need to access (i.e. a list of smartphones that have been within a defined distance from an infected person's phone but not access the data from these phones or upload the data from these phones to a central database).

On 6th April, Facebook started to introduce a new pop up on its platform asking users to fill out a COVID-19 symptom mapping survey from the Delphi epidemiological research center. The initiative is part of its 'Data for Good' programme[85] offering maps on population movement and aggregated sets of information that researchers can use to better understand how "population dynamics influence the spread of the disease". According to Facebook:

> "co-location maps reveal the probability that people in one area will come into contact with people in another, helping illuminate where COVID-19 cases may appear next"[86].

The large technological digital platforms such as Facebook, Google, Apple etc. face a dilemma with the growing expectation that their Applications can assist contact tracing COVID-19:

> "For the tech giants, this plea represents a huge opportunity to get back in the public's good graces, as an industry whose image has taken a beating is being asked, even urged, to step up in a moment of national emergency.
>
> But they also have a problem: Arguably the single most powerful tool at their disposal, their growing troves of data on every American user, is exactly the thing their customers have grown worried about. They're fighting the perception that they're Big Brother — which, in a pandemic, that's exactly why they're useful".[87]

Other institutions have designed their own smartphone App solutions, notably the Massachusetts Institute of Technology (MIT) that has designed '**Private Kit: Safe Paths'**. Professor Raskar describes how it works:

> 'The simplest scenario, and the one we're deploying, is that everyone downloads an App with a GPS-based location logger. When a person is confirmed as having COVID-19, they donate their GPS data to the App's server. This gives a location trail of everywhere they've been for the last two weeks, but without revealing the person's identity. Everyone else who uses the App can look at those trails to compare with their own to see if there was significant overlap, but they never have to share their trails'[88].

85. https://dataforgood.fb.com/approach/
86. https://about.fb.com/news/2020/04/data-for-good/
87. https://www.politico.com/news/2020/03/18/big-tech-coronavirus-134523
88. https://spectrum.ieee.org/the-human-os/biomedical/ethics/halting-covid19-benefits-risks-digital-contact-tracing

The important inter-relationship between contact tracing and testing

There is a close inter-dependency between the tactics of swab testing (whether testing to see if someone has Covid-19 or whether to testing for immunity (having had it knowingly or unknowingly)) and contact tracing and a successful 'Testing and Tracing' strategy would rely on both tactics being rolled out comprehensively across the UK.

The UK Government has recently committed to delivering 100,000 tests by the end of April 2020 as part of its 'Five Pillar Testing Strategy:'[89]

- Swab tests - to check if people already have the virus - in labs run by Public Health England
- Using commercial partners such as universities and private businesses like Amazon and Boots to do more swab testing
- Introducing antibody blood tests to check whether people have had the virus
- Surveillance to determine the rate of infection and how it is spreading across the country
- Building a British diagnostics industry, with help from pharmaceutical giants

As of 2nd April, just:

> *"164,194 people had been tested of which 33,718 were confirmed positive"*[90].

Even if the Government achieves the target of 100,000 tests per day, it would take around two years to test the entire population once, yet many (particularly key workers) will need to be tested multiple times over the coming months and years until a vaccination is able to be administered.

Furthermore, the effectiveness of a contact tracing strategy is entirely dependent on speedy, and accurate positive test results identifying those who are infectious and who are spreading the virus, allowing for fast interventions by contact tracing teams to interdict to prevent further spread. Without accurate and timely positive test results, contact tracing will be greatly sub optimal, allowing many infected persons to continue to spread the disease without their 'contact's being informed and instructed to self-isolate or quarantine.

The volume of swab testing matters because of the correlation between

89. https://www.bbc.com/news/uk-52140376
90. https://www.bbc.com/news/uk-52140376

the number of swab tests administered against the number of people tested positive. The ratio of negative test results to positive test results to date is 4.8:1.

It can be argued that there is little point investing substantial sums of money and effort into a digital contact tracing strategy (using a digital App and contact tracing teams) if the UK is not able to identify quickly an extremely high percentage (if not 100%) of those who have become infected. If swab testing is sufficiently prolific and resourced to be able to test anyone with an immediately identified symptom of COVID-19, then a comprehensive digital contact tracing strategy is worthwhile.

Cultural and behavioural considerations relating to digital contact tracing

The long-term success of an exit strategy from current emergency restrictions across the world will depend on unlocking and sustaining people's "ability to adapt" to a rapidly changing daily life. To achieve this, governments will need to engender a strong collective sense of self-discipline and social responsibility.

If the epidemic cannot be completely eradicated until a vaccine is found and widely distributed, the role that technology will play in tackling COVID-19 in modern societies is likely to increase significantly with consequential social and behavioural impact. In particular, technology is likely to be increasingly used to monitor all aspects of the Covid-19 epidemic as well as the compliance of people responding to the strategies that governments deploy to defeat it.

The successful implementation of a "privacy-friendly" digital contact-tracing App by the UK Government will depend on the willingness of the British people to adapt quickly to new social behaviours in a new "extraordinary" post-lockdown reality. The public will need to commit to a new social contract with its government, one that accepts that some infringements on privacy are a necessary prerequisite for restoring and maintaining wider freedoms.

In a recent IFOP (*Institut Francais d'Opinion Publique*) poll for the think tank Jean-Jaures Foundation [91], a majority of French people (53%) considered the use of a compulsory contact-tracing App too intrusive. The survey also revealed that if the contact-tracing App STOPCOVID was to be used on a voluntary basis, only 46 per cent of French people would agree to use it. This level of subscribers would make digital contact tracking largely ineffective and thus presents France with a dilemma as to whether to attempt to introduce such a tactic.

In another example, in Japan, media reporting suggests that the Government is struggling to 'force' its public to accept constraints on their daily life in anything other than a context of a 'national emergency', raising questions about its ability to make the use a contact-tracing App a compulsory measure[92].

In the case of the United Kingdom, however, the country's national character traits of "self-discipline and quiet resolve"[93] have been consistently commented upon in the media with Ministers reported to

91. Maxime des Gayets for the Foundation Jean Jaures in "Tracking Et Covid : Extension Du Domaine De l'absurde", 12 Avril 2020. https://jean-jaures.org/nos-productions/tracking-et-covid-extension-du-domaine-de-l-absurde

   See also David Chazan in The Telegraph, *"French public hostile to proposed Covid-19 contact-tracing app"*, 12 April 2020.
92. https://www.japantimes.co.jp/opinion/2020/04/02/commentary/japan-commentary/japan-must-take-stronger-measures/#.XpTpDFNKhmB
93. Nick Timothy in The Telegraph, *A crisis is the correct time to invoke the Blitz spirit,*https://digitaleditions.telegraph.co.uk/data/193/reader/reader.html?#!preferred/0/package/193/pub/193/page/57/article/32608

have been surprised by the level of compliance shown by the public to the emergency restrictions that have been imposed to date. If one accepts a characterisation of British culture and psyche as 'resilient and compliant', the Government is likely to gain a good level of support for a voluntary App if privacy concerns can be mitigated transparently. Mitigation will need to include legal and political assurances that personal health data will only be retained within the Department of Health (and not available to other Government agencies without consent) and that smartphone tracing data will not be used for any other purpose other than for defeating COVID-19 and will be destroyed once the epidemic has been defeated.

Nevertheless, steps will still need to be taken to provide incentives to ensure that a very high percentage of the population subscribe to the App. These will need to include the use of national role models, internet influencers and others to ensure that the public understand the wider public good of subscribing to the NHS App created by the Government as opposed to the many other Apps already available and being circulated on the internet (for instance, as of 15th April, the following Apps are currently available on the Apple store: COVID Symptom Tracker, COVID-19, COVID-19 NI, HEATHLYNKED COVID-19 Tracker, PatientSphere for COVID19, Relief Central | COVID-19, PatientMpower for COVID-19, COVID-19 – Medisch Dossier). Parallels can be drawn with similar campaigns that encourage people to donate organs or give blood.

Whilst a high percentage of the UK population are regular users of digital technology, including smartphones, the Government may need to address some skills gaps in order to achieve a high level of subscription to a voluntary smartphone App. For instance, according to the Office of National Statistics, recent internet use in the 65-74 years age group has increased from 52% in 2011 to 83% in 2019, closing the gap with younger age groups. But whilst these figures present a positive outlook, there is still more to be done to close the gap. Age UK[94] offers advice about making the most of using technology and there is also an opportunity for the recently enlisted NHS volunteer responders to be used to remotely offer advice and support to those who want to improve their technological skills.

94. https://www.ageuk.org.uk/information-advice/work-learning/technology-internet/

Privacy and legal dimensions of digital contact tracing

"The ideal of privacy is clearly one of the fundamental values of our culture. There is a close relation between the availability of a protected zone of privacy and the individual's ability freely to develop individuality and creativity. In a society which is frequently intolerant of, or hostile to, nonconformity, freedom from constant surveillance is an important precondition for the development of independent and critically-minded individuals"[95]

In common law countries, there is a robust history of protecting privacy, which is grounded in a person's freedom to enjoy physical and moral autonomy. In a digital age of constantly evolving new technologies, the right to privacy is under challenge and having to be adapted.[96] Privacy constitutes an essential part of functioning liberal democracies and is critical to freedom and independence. Threats to infringements of privacy therefore have important implications for the rule of law, a foundational principle that lies at the heart of the UK as a democratic state.

The severity of the current emergency measures imposed on populations across the world is such that it is likely that most populations will be prepared to forfeit a potentially high degree of privacy as a trade-off for a restoration of their wider freedoms. The key question facing democratic governments however is whether the digital solutions required to upscale contact tracing in order to defeat COVID-19 (a mobile phone App in particular), can be designed to achieve their purpose without unacceptable levels of personal privacy being infringed upon.

As widely reported in the press,[97] public opinion surveys, social media and by human rights organisations, there are legitimate concerns resulting from the use of mass data obtained via contact tracing smartphone Apps to trace and track COVID-19 and send personalised notifications to citizens[98]. The main concerns revolve around the potential loss of privacy and the potential or perceived establishment of a state of mass surveillance during a health crisis that could have long lasting effects on civil liberties. The British public is likely to be alert to the risks of sharing location or contact data with technology companies and the Government and opinions will be influenced by different factors such as age, education and existing use of Apps'. These fears and the associated risks related to privacy are real. Conversely, preserving privacy whilst achieving public health and other national economic and social objectives through the use of contact tracing technology should also be regarded as a realistic goal.

The UK's unwritten constitution does not enshrine a right to privacy for individuals but the European Convention on Human Rights is incorporated

95. Arthur Schafer in *"Privacy: A Philosophical Overview"* in Reader on Legal Theory (Toronto: Captus University Publications, 1993) at 14.

96. MLA 8th ed. Peck, Richard, and Sarah Pringle. *"Privacy, Technology and the Rule of Law."* Advocate (Vancouver Bar Association), vol. 77, no. 6, November 2019, p. 837-846. HeinOnline.

97. Nic Fildes and Javier Espinoza. *Tracking coronavirus: big data and the challenge to privacy. European demands for information from smartphones are raising fear,*in *Financial Times*, 8 April 2020. + list of other press articles cf. the Guardian

98. Nuria Oliver , Emmanuel Letouzé , Harald Sterly , Sébastien Delataille , Marco De Nadai , Bruno Lepri, Renaud Lambiotte , Richard Benjamins , Ciro Cattuto, Vittoria Colizza, Nicolas de Cordes, Samuel P. Fraiberger, Till Koebe, Sune Lehman, Juan Murillo, Alex Pentland, Phuong N Pham, Frédéric Pivetta, Albert Ali Salah, Jari Saramäki, Samuel V. Scarpino, Michele Tizzoni, Stefaan Verhulst, Patrick Vinck, *Mobile phone data and COVID-19: Missing an opportunity?* 25 March 26, 2020

into national law by way of the Human Rights Act (1998) which provides for a limited right of respect towards an individual's privacy and family life.

The Data Protection Act (DPA) 2018[99] also places the UK at the forefront of global data protection standards. The 2018 Act corresponds to the UK's implementation of the European General Data Protection Regulation (GDPR). It regulates the holding of an individual's personal data by companies and consequently has an impact on information concerning the private lives of individuals. The original intention behind the Data Protection Act 2018 was to modernise data protection laws for the digital age and in the words of the then Secretary of State for Digital, Culture, Media and Sport, Matt Hancock, to give:

> *"people more control over their data, supports businesses in their use of data, and prepares Britain for Brexit. In the digital world strong cyber security and data protection go hand in hand. The 2018 Act is a key component of our work to secure personal information online."*[100]

The overarching GDPR framework provides for exemptions that make it feasible for the UK Government to create a bespoke legal framework to protect the rights of individuals in a post-lockdown context while ensuring that the UK authorities are able to tackle this unprecedented pandemic with the appropriate means and use of mass data obtained from smartphone and other technological sources. The introduction of a new exemption in the 2018 DPA will however need to be strictly framed and time limited to avoid potential abuses.

The six data protection principles that apply to personal data processed under Part 4, chapter 2 (86-91) of the 2018 Data Protection Act (intelligence services processing) could serve as a basis for creating a new exemption that will give the UK authorities all the necessary means to tackle the exceptional circumstances of the pandemic and allow a progressive return to economic, social and political normality:

- processing must be lawful, fair and transparent;
- the purposes of processing must be specified, explicit and legitimate;
- personal data must be adequate, relevant and not excessive;
- personal data must be accurate and kept up to date;
- personal data must be kept no longer than is necessary;
- personal data must be processed in a secure manner.

By making sure the privacy laws are updated to take into account the unprecedented context of the COVID-19 pandemic and the legal concerns associated with using a contact tracing App, the UK's high standards of data protection could be upheld.

The race by governments across the world to find digital solutions to combat the COVID-19 is likely to continue to overtake attempts to question the legitimacy of accumulating, storing and analysing mass data

99. The Data Protection Act 2018 replaced the former Data Protection Act 1998 and controls how the personal information is used by organisations, businesses or the government.
100. Data Protection Act 2018 Factsheet – Overview https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/711162/2018-05-23_Factsheet_1_-_Act_overview.pdf

from their populaces for this purpose.

In an article entitled: 'Privacy agenda threatened in West's virus fight', it was said that:

> "Government bodies in the U.S. and Europe have spent years debating or advancing tighter safeguards on the handling of people's personal data, driven by revelations of abuses by intelligence agencies and big tech companies. But now privacy concerns on both sides of the Atlantic are at risk amid the urgent fight against the coronavirus pandemic. In some cases, it's with at least grudging acceptance from privacy advocates".[101]

In most democratic states in recent times, populations have become more concerned about intrusions on their privacy from Silicon Valley technological companies such as Google and Apple than from their state governments. The sheer scale of personal data being collected by some private sector companies through their smart phone Apps is now widely understood:

> "We don't live in a culture of public trust when it comes to data," says David Leslie, an ethicist at the Alan Turing Institute who studies the governance of data-driven technologies. "We live in this age that has been called the age of surveillance capitalism, where … our data is abused and exploited." But, he adds, authorities and the public will have to weigh the value of privacy against the possibility that data collection could save millions of lives. "These are not normal times."[102]

But the recent infringements of personal liberty imposed by governments on their populations in order to contain the worse effects of the COVID-19 pandemic have themselves been so unprecedented, intrusive and socially damaging that they make any concerns about the loss of personal privacy through governments now introducing digital contact tracing pale into relative insignificance.

In the absence of a vaccine and / or herd immunity, governments are already being forced into introducing extreme measures to contain the virus. The introduction of digital contact tracing measures are a necessary extension of these measures and far less intrusive and restricting than lockdowns of people in their homes.

Some are questioning the validity of the measures being imposed by governments and warning about the resulting loss of freedom:

> "In recent weeks, we have observed a number of concerning signs that authoritarian regimes are using COVID-19 as a pretext to suppress independent speech, increase surveillance, and otherwise restrict fundamental rights, going beyond what is justified by public health needs," said Michael J. Abramowitz, president of Freedom House. "Some regimes have also resorted to such measures to cover up their mismanagement of the contagion, putting the public in greater danger. But even democracies are at risk of disregarding their core principles as they struggle to combat the outbreak, which could have lasting consequences after the crisis is over," he added"[103]

101. https://www.politico.eu/article/privacy-agenda-threatened-in-wests-virus-fight/
102. https://www.sciencemag.org/news/2020/03/cellphone-tracking-could-help-stem-spread-coronavirus-privacy-price
103. https://freedomhouse.org/article/spotlight-freedom-impact-coronavirus-basic-freedoms

There are examples of privacy intrusions in countries using digital contact tracing through mobile phone data. For instance:

> *"In South Korea, vigilante groups started forming on Facebook and social media around the data from contact tracing. They became armchair detectives. They would piece together information about a person in their neighbourhood and gossip and shame people or discover parts of their life that are extremely private"*[104].

There are also examples of businesses being subjected to blackmail:

> *"Since some contact tracing App's allow people to self-report their symptoms, bad actors will go to a shop and threaten to report symptoms from that location unless they are given a ransom. There are a lot of those stories from China and South Korea. And the malicious actors don't even have to physically go to the shop; they can do it remotely sitting on a computer since GPS spoofing and Bluetooth spoofing is pretty straightforward"*[105].

Nevertheless, many will consider that freedom has a price in the current new world order and loss of some privacy is a relatively small price to pay providing that it is justified on grounds of freedom and liberty and properly explained to the public. But in order to prevent this loss of privacy from becoming a new norm, governments will need to build legal and regulatory safeguards into the introduction of digital contact tracing measures.

These same governments will need to convince their populations that they should hand over their personal health data on a regular basis in the wider interests of their nation's health. This is a major challenge and one that will need to be explained with transparency and openness.

The recent joint announcement by both Google and Apple[106] will greatly assist governments attempting to introduce digital contact tracing as part of their future COVID-19 suppression strategies. The proposal to design an anonymised contact tracing capability into every phone will in future assist governments to use this tactic whilst protecting individual privacy and to provide reassurance to their populations about state intrusion. That said, governments may still want to develop and roll out their own smartphone Apps alongside this in-built technology as there are other benefits to rolling out national voluntary digital Apps, not least, using them to communicate national Government messages about the dangers and spread of COVID-19.

In the current context of a global pandemic affecting nations across the world, populations will forfeit their privacy for freedom as explained by Vittoria Colao, former Vodaphone CEO:

> *"it is not a question of spying on everyone forever but of saving lives for a time that demands temporary rules… we trust Uber to know everywhere we go, we trust Gmail with everything we write. If we don't trust the NHS without health data when who do we trust?"*[107]

104. https://www.bbc.com/news/world-asia-51733145
105. https://spectrum.ieee.org/the-human-os/biomedical/ethics/halting-covid19-benefits-risks-digital-contact-tracing
106. https://www.Apple.com/newsroom/2020/04/Apple-and-google-partner-on-COVID-19-contact-tracing-technology/
107. https://www.ft.com/content/7c-fad020-78c4-11ea-9840-1b8019d9a987?accessToken=zwAAAXFYwT_Akc98-tAgeMQR6tOYQBuAGdmphw.MEYCIQCyyXvSNq_T-4HH2raPip-P72u6WL97NuN3uWbcarB9p5gI-hANk-L-EvhXK6gbWg37YpdPEmLJI1_AD-P2Fi08fU2XzBA&sharetype=gift?token=1ae94916-e0e4-4ecd-9f89-e6b-ca9af3914

Operational implications of digital contact tracing

Since the outset of the emergency response to the COVID-19 epidemic in the UK, the Government has been making political and policy decisions based on expert scientific advice from the various committees that inform the overarching Cabinet Office Briefing Room (COBR), including the Scientific Advisory Group for Emergencies (SAGE),[108] chaired by the Chief Scientific Advisor[109], New and Emerging Respiratory Virus Threats Advisory Group[110], Scientific Pandemic Influenza Group on Modelling (SPI-M) in the Department for Health and Social Care,[111] and the independent Scientific Pandemic Influenza Group on Behaviours. The Government strategy as extolled by the Prime Minister Boris Johnson, has been to "follow the scientific advice"[112] which has, to date, been comprehensive and communicated effectively through national daily briefings.

The reactive strategy is informed by scientific modelling, academic papers and analysis of data from the Department of Health, NHS and other governments departments and agencies.

As the country approaches the prospect of the lifting of the significant social isolation measures currently being imposed on the population, the Government's strategy will need to be significantly more **proactive,** pivoting away from the current **reactive** crisis management towards a new forward leaning strategy of suppression ('hunting down the virus'[113]) and prevention of further outbreaks.

Testing is already critically important but will need to scale at pace if the emergency measures currently in place are relaxed. Similarly, the Government will need to be able to undertake contact tracing with a much higher degree of efficiency and speed than has been demonstrated up until now. The introduction of digital contact tracing is the only way of achieving this ambition.

To achieve this, it is recommended that the UK Government extend its Five Pillar Testing Strategy to a Six Pillar **Testing and Tracing Strategy** by introducing digital contact tracing as a Sixth Pillar.

Simultaneously, it should now move to a 24/7 operational footing, treating COVID-19 as an enemy that needs to be suppressed and ultimately defeated. To that end, it needs to create a national 24/7 multi agency **Testing and Tracing Command Centre** responsible for the analysis of the spread of the coronavirus across the country through test results and advanced contact tracing using digital technologies. The centre should oversee analysis of the data and the enforcement of self-isolation / social

108. https://www.gov.uk/government/groups/scientific-advisory-group-for-emergencies-sage
109. https://www.gov.uk/government/groups/chief-scientific-advisers
110. https://www.gov.uk/government/groups/new-and-emerging-respiratory-virus-threats-advisory-group
111. https://www.gov.uk/government/groups/scientific-pandemic-influenza-sub-group-on-modelling
112. https://www.telegraph.co.uk/politics/2020/03/17/boris-johnson-coronavirus-speech-schools-uk-government-advice/
113. https://www.ft.com/content/1e390ac6-7e2c-11ea-8fdb-7ec06edeef84

distancing measures in outbreak hotspots in fast time to suppress / extinguish the virus from the country. It should also be responsible for communicating key messages to the public on the measures that are being taken, via websites and briefings, replacing the current daily national briefings that the Government is undertaking.

The **Testing and Tracing Command Centre** should accelerate the development of digital solutions and urgently launch a national voluntary App to significantly improve 'contact tracing' of those infected with coronavirus. Digital solutions should protect privacy whilst achieving the purpose of obtaining tracing data that can be acted upon.

The Government should appoint a single operational lead for the **Testing and Tracing Command Centre**, experienced in national Command, Control, Co-ordination and Communication (often referred to as C4). The military, police and intelligence agencies all have experience in establishing command similar 'fusion' command centres in fast time to achieve strategic objectives such as those that are needed to combat COVID-19. The Government should draw on this expertise as it looks forward to a new strategy after the current restrictions are released.

Cyber security and digital contact tracing

For contact tracing to be as effective as it needs to be in order to stop COVID-19 from spreading, the data entered into digital applications needs to be reliable and accurate. Inaccurate or misleading data entered onto voluntary Apps could have far reaching negative consequences, for instance, hackers or fraudsters entering data on a stolen or fraudulent smartphone in a crowded place in order to convince people that they have come into contact with someone suffering from COVID-19, potentially forcing large numbers of people to go into self-isolation. Malign actors could target particular groups using this technique will potentially perverse ramifications on the use of police powers to enforce self-isolation in the future. Google and Apple and governments themselves will need to explore how these negative outcomes can be prevented by taking account of them in the design stages of operating systems and smartphone Apps.

Some researchers have also exposed flaws and vulnerabilities in Government approved coronavirus contact tracing Apps. For instance, concerns have been raised about the security of the contact tracing application **CoronApp** that was launched by the Columbian Government on 9th March:

> *"The CoronApp-Columbia App had a vulnerability where it was sending Personal Health Information (PHI) and Personally Identifiable Information (PII) data in plaintext" said Zack Allen, director of threat intelligence at ZeroFox… this includes passports numbers, passwords, and self-disclosed health information"*[114].

114. https://www.infosecurity-magazine.com/news/vulnerabilities-covid19-App/

Conclusions

Even optimistic forecasts predict that a vaccination for COVID-19 will not be available for another 12-18 months presenting governments around the world with a major dilemma. Having enforced self-isolation and movement restrictions on their populations, they are desperately looking for a new strategy to defeat COVID-19 and are faced with a limited number of options.

Some argue that 'herd immunity' is the only way out of the dilemma but this is a high risk strategy that is difficult to implement without countries potentially suffering unacceptably high numbers of deaths (although some states may be tempted to try) and it will take time to build sufficient capacity within health services (e.g. ventilators) to be able to deal with (and not be overwhelmed by) intermittent surges in COVID-19.

Against this backdrop, there is increasing evidence that mass swab testing alongside digital contact tracing strategies, have already mitigated the worst effects of COVID-19 in countries such as China, South Korea and Singapore but it is undeniable that these strategies, particularly digital contact tracing, are intrusive and an infringement on privacy.

This paper argues, however, that in the absence of a vaccine or herd immunity, nation states now have little choice but to design their own digitalised contact tracing strategies alongside their mass testing regimes. Viable alternatives do not exist and governments are likely to follow the same path - designing a plethora of different digital Apps that will accumulate the health and tracking data needed to identify and snub out new outbreaks of the disease in a new global phase of 'suppression'. The leaders in technology such as Apple and Google have demonstrated that they can assist with designing universal solutions to digital Apps that limit infringements to privacy but these are in the early design stages.

The countries that succeed in this endeavour will also create centralised command and control centres (as seen in Taiwan and Singapore) and utilise Big Data and Artificial Intelligence techniques to inform contact tracing and extinguish episodic outbreaks through instigating self-isolation of those that have come into contact with infected persons.

Populations across the world are likely to be prepared to forfeit their privacy to protect their freedom in this new world order but there are positive steps that governments will need to take to ensure that privacy is not completely extinguished or compromised unnecessarily. These include legislating to set boundaries around the acquisition, retention and use of big data used in contact tracing and ensuring that data collection is voluntary.

Governments will need to garner the support and trust of their populations through transparency and effective communication in order for them to be encouraged to share their health and other data on digital contact tracking Apps. People will need to be reassured and convinced that their data will only be used to address the current COVID-19 epidemic and not be shared with or used by police or intelligence agencies more widely and for other purposes without consent.

There is a wider pressing question too about the need for governments to collaborate together to find international solutions to preventing a second wave of COVID-19, once current social distancing measures have been relaxed. Currently, nation states are operating independently, investing substantial sums of money in digital and other solutions that are country specific, yet many of these could be universally applied, as explained by Bill Gates who has called for a "global approach" to fighting the disease[115]. COVID-19 is a global challenge that requires global thinking and solutions. This is not a time for countries to 'self-isolate'.

115.https://www.telegraph.co.uk/global-health/ science-and-disease/coronavirus-bill-gates-calls-global-agreements-masks-treatments/