

A Survey of Requirements for COVID-19 Mitigation Strategies

Part I: Newspaper Clips

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1 Introduction

The COVID-19 pandemic has influenced virtually all aspects of our lives. Across the world, countries have applied wildly varying mitigation strategies for the epidemic, ranging from minimal intrusion in the hope of obtaining “herd immunity”, to imposing severe lockdowns on the other extreme. The strategies are based on various social, political, and technological instruments. According to Digital Rights Tracker, as of June 2020:

- Contact Tracing Apps were being used in 28 countries,
- Alternative digital tracking measures were active in 35 countries,
- Physical surveillance technologies were in use in 11 countries,

- COVID-19-related censorship had been imposed by 18 governments,
- Internet shutdowns continued in 3 countries despite the outbreak (Woodhams, 2020).

It seems clear at the first glance what all those measures are trying to achieve, and what the criteria of success are. But is it really that clear? Quoting an oft-repeated phrase, with COVID-19 we fight

an unprecedented threat to *health* and *economic stability*¹ (Soltani et al., 2020)

While fighting it, we must

Protect *privacy*, *equality* and *fairness* (Morley et al., 2020)

and

do a *coordinated assessment* of *usefulness*, *effectiveness*, *technological readiness*, *cyber security risks* and threats to *fundamental freedoms* and *human rights* (Stollmeyer et al., 2020)

Moreover, we should do it in a way that

needs to be *ethical*, *trustworthy*, *locally rooted*, and *adaptive to new data on what works*. (Muscato, 2020)

Taken together, this is hardly a straightforward set of goals and requirements. Thus, paraphrasing (Stollmeyer et al., 2020), one may ask:

What problem does a COVID mitigation strategy solve exactly?

Even a quick survey of news articles, manifestos, and research papers published since the beginning of the pandemic reveals a diverse landscape of postulates and opinions. Some authors focus on medical goals, some on technological requirements; others are more concerned by the economic, social, or political impact of a containment strategy. The actual stance is often related to the background of the author (in case of a researcher) or their information sources (in case of a journalist). We postulate that one should identify the relevant requirements before committing to a particular mitigation strategy. In fact, this should be done before any informal or formal analysis and assessment of the available strategies, with as little bias as possible.

One way to achieve it is through an overview of what is considered relevant by the general public, and referred to in the media. To this end, we have collected a number of quotes and “news clips” touching on the topic. We looked especially at the most popular IT solution proposed to contain the epidemic, namely *digital contact tracing apps*. The idea has generated a fair amount of controversy, and

¹The highlighting of selected words and phrases is due to the authors of this report throughout the text.

for a while virtually dominated the discussions and press coverage of COVID-19 containment strategies. Eventually contact tracing apps have been deployed on a large scale, with several hundred million downloads across the world,² leading to the discovery of various flaws and even more discussion on what characterizes acceptable and effective containment measures.

In this paper, we present some snippets from the press and Internet media, published between March and June 2020, that mention the possible goals and requirements for a mitigation strategy. The snippets are sorted thematically into several categories, such as health-related goals, social and political impact, civil rights, ethical requirements, etc. While most of the presented news clips focus on digital contact tracing for COVID-19, it is easy to see that the relevance of the requirements goes beyond contact tracing apps, and applies to any large scale epidemic: also the ones that may happen in the future.

We emphasize that **we do not endorse the opinions being presented in the quotes**. We also **do not comment on their content**. We merely use the quotes to collect relevant keywords and conceptual categories. The assessment of how the requirements are addressed by different mitigation strategies, and which strategy to select, is a matter for systematic analysis that should follow in the next step.

2 Epidemiological and Health-Related Concerns

Clearly, an epidemic is first and foremost a threat to people’s health and lives. Accordingly, we begin with media clips related to this aspect of COVID-19 mitigation strategies.

2.1 Epidemiological Goals

Containment measures (and contact tracing apps in particular) should slow the spread of the virus, decrease the transmission rate, and save lives:

Since the outbreak of COVID-19, governments around the world have implemented a range of digital tracking, physical surveillance and censorship measures in a bid to *slow the spread of the virus*. (Woodhams, 2020)

Lockdowns *prevented* around 3.1 million *deaths* in 11 European countries, according to a new modelling study (AFP, 2020)

Researchers also calculated that the interventions had *caused the reproduction number* – how many people someone with the virus infects – *to drop* by an average of 82 percent, to below 1.0. (AFP, 2020)

²The Indian app Aarogya Setu alone has already had more than 100 million downloads (Tim, 2020).

Contact tracing can be an important component of an *epidemic response* especially when the prevalence of infection is low. Such efforts are most *effective* where testing is rapid and widely available and when infections are relatively rare. (Soltani et al., 2020)

To best meet public health needs, digital technology should be able to *trace the spread of the virus, identify dangerous Covid-19 clusters and limit further transmission*. The essential goal is to *register contacts between potential carriers and those who might be infected*. (Ilves, 2020)

designed and built by the NHS to help *slow the spread of the coronavirus* (NCS, 2020)

you'll be helping to *slow the transmission of the coronavirus*. (NCS, 2020)

even finding a fraction of cases through contact tracing will help *slow the virus's spread*. (Steinhauer and Goodnough, 2020)

Contact tracing via smartphone is a powerful way to *tackle the spread of coronavirus*, but it mustn't be done at the expense of individual civil rights. (Bicheno, 2020)

Smittestopp is an app that will *help the health authorities to limit the transmission of coronavirus* and alert users with text messages about close contact with infected persons. (hel, 2020)

2.2 Effectiveness of Epidemic Response

The measures should be effective in containing the epidemic:

what's missing in most debates is how *effective* the apps actually are (Stollmeyer et al., 2020)

We and many others have pointed out a host of pitfalls for voluntary, self-reported coronavirus apps of the kind Apple, Google, and others contemplate. First, app notifications of contact with COVID-19 are likely to be simultaneously both *over-* and *under-inclusive*. (...) Individuals may be flagged as having contacted one another despite very low possibility of transmission—such as when the individuals are separated by walls porous enough for a Bluetooth signal to penetrate. Nor do the systems account for when individuals take precautions, such as the use of personal protective equipment, in their interactions with others. At least as problematic is the issue of *false negatives* (...) Contact-tracing apps therefore *cannot offer assurance* that going out is safe, just because no disease has been reported in the vicinity. (Soltani et al., 2020)

Inaccurate results are likely to lead to a high number of false positives and negatives that may *adversely impact the relaxation of lockdown measures*. (Woodhams, 2020)

On the Isle of Wight, the NHS contact tracing app *is making a difference*. Around 25 people per day are being tested for coronavirus after reporting it through their phones (Burgess, 2020)

Initially, the hope was that contact tracing apps would be a *silver bullet* for contact tracing. Evidence shows this is not the case. Many European countries have been using these apps for months with *limited success*. (Redmiles, 2020)

Contact tracing apps have struggled with *low adoption rates, issues with the accuracy of the Bluetooth technology* on which the apps rely to detect when app users come into contact with each other, and ensuring that app users remember to bring their phones with them and to upload their coronavirus test results. (Redmiles, 2020)

Tracking those exposed is so far behind the virus raging in most places that many public health officials believe the money and personnel involved would be better spent on other resources, like increasing test sites, helping schools prepare for reopening and educating the public about mask wearing. (Steinhauer and Goodnough, 2020)

This connects to *timeliness* which is an essential feature of an effective response strategy:

It's a *race against time* (Steinhauer and Goodnough, 2020)

2.3 Information Flow to Counter the Epidemic

The strategy should support rapid information flow to the most concerned:

As the global fight against the COVID-19 pandemic continues, much of the world is pinning its hopes of easing lockdowns on being able to *quickly identify people who might have been exposed to the virus*. (Zastrow, 2020)

Technologies to *rapidly alert people* when they have been in contact with someone carrying the coronavirus SARS-CoV-2 are part of a strategy to *bring the pandemic under control*. (Morley et al., 2020)

some public health and consumer advocacy groups have urged the use of apps that allow people who test positive for Covid-19 anonymously message recent contacts. (POL, 2020)

a retired home-care nurse (. . .) said she would welcome an app to *help spread word of possible exposure*. (Timberg, 2020)

Smittestopp is an app that will help the health authorities to limit the transmission of coronavirus and *alert users with text messages about close contact with infected persons*. (hel, 2020)

2.4 Tradeoffs

Clearly, there are tradeoffs between epidemiological efficiency and other concerns, as we will also see in the subsequent sections:

The immediate goal for governments and tech companies is to *strike the right balance* between *privacy* and the *effectiveness of an application to limit the spread of Covid-19*. (Ilves, 2020)

So far the clear evidence is that greater control of populations has *worked better at stopping the coronavirus spread* than a more relaxed attitude (McCarthy, 2020)

Some states are raising concerns that the [Google and Apple] app won't allow them to *collect enough information* due to privacy concerns. (POL, 2020)

China's Health Code system (...) records a user's spending history in order to *deter them from breaking quarantine* (Clarence, 2020)

2.5 Monitoring Pandemic and Containment Strategy

The containment strategy should enable monitoring the state of the pandemic, the behavior of people, and the effectiveness of the strategy itself:

Most states are waiting to see whether the Bluetooth-based release from Apple and Google, which is supposed to automatically notify people when they come close to someone who's tested positive, will be an effective way to *monitor outbreaks*. (POL, 2020)

These serology tests can provide important data on *how COVID-19 is spreading through a population*. There is also hope that the presence of certain antibodies may signify immunity to future infection (Frasier, 2020)

"The police won't have to monitor the places of quarantine," said Mateusz Morawiecki, the Polish prime minister, when announcing the country's coronavirus app would become mandatory. *"We will know if people are following the rules."* (Scott and Wanat, 2020)

Effective monitoring is often at odds with other requirements, especially privacy:

There are of course advantages to [the centralized] approach [of contact tracing], *models can be adapted quicker and additional analysis can be performed*, but the question which remains is whether this outweighs the *risk to security and privacy* (Davies, 2020)

2.6 Specific Goals of Digital Contact Tracing

Digital measures for COVID-19 mitigation often have more specific goals and desirable properties.

Ultimately, contact tracing is a *public health intervention*, not an individual health one. It can *reduce the spread of disease through the population* (Soltani et al., 2020)

[Contact tracing apps are] a way to *enhance traditional forms of contact tracing to find potential new infections* (Timberg, 2020)

The goal of contact tracing for Covid-19 is to *reach people* who have spent more than 15 minutes within six feet of an infected person and *ask them to quarantine* at home voluntarily for two weeks even if they test negative, monitoring themselves for symptoms during that time. (Steinhauer and Goodnough, 2020)

Traditional contact tracing works by interviewing those infected with COVID-19 about whom they have encountered during the prior two weeks. The contact tracers then contact those who have been exposed to *notify them of exposure*. (Redmiles, 2020)

2.7 Prerequisites for Successful Contact Tracing

Contact tracing at scale works successfully only under certain conditions:

Contact tracing generally works best, public health experts say, when a disease is *easily detected from its onset*. That is often impossible with the coronavirus because a large percentage of those infected have no symptoms. (Steinhauer and Goodnough, 2020)

Perhaps most harmful to the effort have been the persistent *delays* in getting the results of diagnostic tests. Often by the time an individual tests positive, it's too late for the health care workers tracking that person to do anything. In contrast, when sports teams and staff of the White House test people constantly, with fast turnarounds, contact tracing is *instant* and *effective*. (Steinhauer and Goodnough, 2020)

Contact tracing, a cornerstone of the public health arsenal to tamp down the coronavirus across the world, *has largely failed* in the United States; the *virus's pervasiveness* and major *lags in testing* have rendered the system almost pointless. In some regions, large swaths of the population have *refused to participate* or cannot even be *located*, further hampering health care workers. (Steinhauer and Goodnough, 2020)

Some public health experts now believe that, at the very least, testing and contact tracing need to be *scaled back in places with major outbreaks*. In some places, they say the effort may never succeed. (Steinhauer and Goodnough, 2020)

3 Economic and Social Impact

Most measures to contain the epidemic are predominantly social (lockdown being a prime example), and have strong social and economic impact.

3.1 Economic Stability

The impact of the containment strategy on the economy is of prime importance:

The unprecedented threat from the novel coronavirus has confined many Americans to their homes, distancing them from one another at *great cost to local economies* and personal well-being. (Soltani et al., 2020)

In a separate study, also published in Nature, researchers from UC Berkeley used a different method – econometric modelling used to assess how policies *affect economic growth* – to evaluate containment policies in China, South Korea, Italy, Iran, France and the United States. (AFP, 2020)

[Contact tracing apps] help make *resumption of economic and social activities safer* in the months ahead. (Timberg, 2020)

[Australian Prime Minister, Scott Morrison:] “If you want to *return to a more liberated economy and society*, it is important that we get increased numbers of downloads when it comes to the Covidsafe app.” (Taylor, 2020)

3.2 Impact on Society

Regarding the available measures in general, and contact tracing apps in particular:

we know very little about them or how they could *affect society*. (O’Neill et al., 2020)

As the global fight against the COVID-19 pandemic continues, much of the world is pinning its hopes of *easing lockdowns* on being able to quickly identify people who might have been exposed to the virus. (Zastrow, 2020)

[The Covidsafe app] was sold as the key to *unlocking restrictions* (...) but as the country begins to open up, the role of the Covidsafe app in the recovery seems to have dropped to marginal at best. (Taylor, 2020)

The health minister, Greg Hunt, tweeted that [the Covidsafe app] was the key to *being allowed to go back to watching football*. (Taylor, 2020)

3.2.1 Disinformation and Information Abuse

We worry that contact-tracing apps will serve as vehicles for *abuse and disinformation*, while providing a *false sense of security* to justify reopening local and national economies well before it is safe to do so. (Soltani et al., 2020)

Since the outbreak of COVID-19 there has been a rapid acceleration in the *spread of mis- and disinformation*. To *control this*, governments and social media platforms have sought to stringently *regulate online content* and *promote official facts and figures from international health organisations*. (Woodhams, 2020)

3.2.2 Potential for Discrimination and Creation of Social Divides

There is also a very real danger that these voluntary surveillance technologies will effectively become *compulsory for any public and social engagement*. (Soltani et al., 2020)

there is a real risk that these mobile-based apps can *turn unaffected individuals into social pariahs, restricted from accessing public and private spaces or participating in social and economic activities*. (Soltani et al., 2020)

protecting those communities who can be (...) harmed by the collection and exploitation of personal data. (Soltani et al., 2020)

Protections need to be put in place to expressly *prohibit economic and social discrimination on the basis of information and technology designed to address the pandemic*. (Soltani et al., 2020)

3.3 Political Impact

The pandemic creates new space for political manipulation and changes the distribution of power:

the issue of malicious use is paramount—particularly given this current climate of disinformation, astroturfing, and *political manipulation*. Imagine an unscrupulous political operative who wanted to dampen voting participation in a given district, or a desperate business owner who wanted to stifle competition. Either could falsely report incidences of coronavirus without much fear of repercussion. Trolls could sow chaos for the malicious pleasure of it. Protesters could trigger panic as a form of civil disobedience. A foreign intelligence operation could shut down an entire city by falsely reporting COVID-19 infections in every neighborhood. (Soltani et al., 2020)

In the long run, however, this poses a far more fundamental question: *how much can the decisions of sovereign democratic countries be overruled by technology companies* [i.e., Google and Apple]? (Ilves, 2020)

3.4 Wellbeing, Mental Health, and Social Relationships

The unprecedented threat from the novel coronavirus has *confined many Americans to their homes, distancing them from one another* at great cost to local economies and *personal well-being*. (Soltani et al., 2020)

we all long for *freedom from lockdowns and home confinement* (Stollmeyer et al., 2020)

3.5 Costs, Human Resources, Logistics

The financial costs incurred by the containment measures, as well as the engaged human resources, are another important factor.

The government has been forced to abandon a centralised coronavirus contact-tracing app after *spending three months and millions of pounds* on technology that experts had repeatedly warned would not work. (. . .) [T]he health secretary said the government would not “*put a date*” on when the new app may be launched, although officials conceded it was likely to be in the autumn or winter. (Hern, 2020)

"*The police won't have to monitor the places of quarantine*," said Mateusz Morawiecki, the Polish prime minister, when announcing the country's coronavirus app would become mandatory. "We will know if people are following the rules." (Scott and Wanat, 2020)

The lure of *automating the painstaking process* of [manual] contact tracing is apparent. (Soltani et al., 2020)

In Michigan, Ottawa County's public health department *automated* contact tracing symptom checks and follow-ups. (Redmiles, 2020)

As coronavirus cases reach new peaks, surpassing 200,000 cases a day in the United States, *public health departments are overwhelmed*. Departments are racing to hire yet more contact tracers and some are even asking *people to do their own contact tracing and notification*. (Redmiles, 2020)

The logistics of the strategy (in particular, coordination and cooperation between different institutions and authorities) also plays a role:

U.S. efforts (. . .) are running into an all-too-familiar problem that has plagued the pandemic response: a lack of *national coordination*. (Tahir and Lima, 2020)

the federal government has so far failed to institute concrete *privacy standards*. (Tahir and Lima, 2020)

Similarly, the European Commission postulated

a set of technical specifications to ensure a *safe exchange of information between national contact tracing apps* based on a decentralised architecture [to] *work seamlessly when users travel to another EU country* which also follows the decentralised approach. (Eur, 2020)

4 Compliance with Norms, Rights, and Obligations

In this section, we look at requirements that aim at the long-term robustness and resilience of the social structure, such as ethical and legal requirements.

4.1 Ethical Aspects

The mitigation strategy must be *ethically justifiable* (Morley et al., 2020). Importantly:

ethical and social considerations [other than privacy] must not be cast aside in the rush to quell the pandemic. For instance, contact-tracing apps should be *available and accessible to anyone*, irrespective of the technology needed or their level of digital literacy.

(...) Even in a crisis, a ‘try-everything’ approach is dangerous when it ignores the real costs, including *serious and long-lasting harms to fundamental rights and freedoms*, and the opportunity costs of *not devoting resources to something else*. (Morley et al., 2020)

Some of these [mitigation measures] may well be *proportionate, necessary* and *legitimate* during these unprecedented times. However, others have been rushed through legislative bodies and implemented *without adequate scrutiny*. (Woodhams, 2020)

the data agency Datatilsynet (...) said the restricted spread of coronavirus in Norway, as well as the app’s limited effectiveness due to the small number of people using it, meant the invasion of privacy resulting from its use was *disproportionate*. (Oslo, 2020)

Note that the ethical considerations do not necessarily oppose strict measures of containing the epidemic. In particular:

Temporarily restricting some fundamental rights and freedoms *might be ethically justifiable* in the context of hastening the end of the pandemic. Quarantining individuals, for example, helps to prevent the spread of the disease. Arguably, it might be unethical not to use digital tracing apps when necessary. Nevertheless, much depends on the effectiveness of the app, the goal pursued, the type of system and the context in which it will be deployed.

(...) To be ethical, a contact-tracing app must abide by four principles: it must be *necessary*, *proportional*, *scientifically valid* and *time-bound*. These principles are derived from the European Convention on Human Rights, the International Covenant on Civil and Political Rights (ICCPR) and the United Nations Siracusa Principles, which specify the provisions in the ICCPR that limit how it can be applied. (Morley et al., 2020)

An app's *implementation strategy* and *impact* must also be considered. Something that looked good on paper can turn out to be ineffective in practice. (...) *If an app fails, it becomes unnecessary, and thus unethical.* (Morley et al., 2020)

Moreover, the terms and conditions of such an app should be *just* (Scott and Wanat, 2020). One must also keep in mind that ethical norms and their interpretation vary depending on the actual place, time, and social context.

In practice, there will be *trade-offs*. These will *depend on the laws, values, attitudes and norms in different regions*, as well as on *changes over time* in the spread and scale of the virus and the available technology. (...) Similarly, what was ethically justifiable in one place yesterday might not be so tomorrow. (Morley et al., 2020)

4.1.1 Detailed Criteria

The detailed guidelines for ethical justifiability of a contact-tracing app from (Morley et al., 2020) are presented below.

Principles: is this the right app to develop?

1. Is it *necessary*?
 - Yes, it must be developed to save lives (+).
 - No, there are better solutions (-).
2. Is it *proportionate*?
 - Yes, the gravity of the situation justifies the potential negative impact (+).
 - No, the potential negative impact is disproportionate to the situation (-).
3. Is it *sufficiently effective, timely, popular and accurate*?
 - Yes, evidence shows that it will work, is timely, will be adopted by enough people and yields accurate data and insights (+).
 - No, it does not work well, is available too late or too early, will not be used widely, and is likely to collect data that have false positives and/or false negatives (-).
4. Is it *temporary*?
 - Yes, there is an explicit and reasonable date on which it will cease (+).
 - No, it has no defined end date (-).

Requirements: is this app being developed in the right way?

5. Is it *voluntary*?
 - Yes, it is optional to download and install (+).
 - No, it is mandatory and people can be penalized for non-compliance (-).
6. Does it *require consent*?
 - Yes, people have complete choice over what data are shared and when, and can change this at any time (+).
 - No, default settings are to share everything all the time, and this cannot be altered (-).
7. Are the *data kept private* and *users' anonymity preserved*?
 - Yes, data are anonymous and held only on the user's phone. Others who have been in contact are notified only that there is a risk of contagion, not from whom or where. Methods such as differential privacy are used to ensure this. Cyber-resilience is high (+).
 - No, data are (re)identifiable owing to the level of data collected, and stored centrally. Locations of contacts are also available. Cyber-resilience is low (-).
8. Can users *erase the data*?
 - Yes, they can do so at will; all data are deleted at the end point (+).
 - No, there is no provision for data deletion, nor a guarantee that it can ever be deleted (-).
9. Is the *purpose of data collection* defined?
 - Yes, explicitly; for example, to alert users that they have encountered a potentially infected person (+).
 - No, the purposes of data collection are not explicitly defined (-).
10. Is the purpose *limited*?
 - Yes, it is used for tracing and tracking of COVID-19 only (+).
 - No, it can be regularly updated to add extra features that extend its functionality (-).
11. Is it *used only for prevention*?
 - Yes, it is used only to enable people voluntarily to limit spread (+).
 - No, it is also used as a passport to enable people to claim benefits or return to work (-).
12. Is it used for *compliance*?
 - No, it is not used to enforce behaviour (+).
 - Yes, non-compliance can result in punishment such as a fine or jail time (-).
13. Is it *open-source*?
 - Yes, the code is publicly available for inspection, sharing and collaborative improvement (+).
 - No, the source code is proprietary, and no information about it is provided (-).
14. Is it *equally available*?
 - Yes, it is free and distributed to anyone (+).
 - No, it is arbitrarily given only to some (-).

15. Is it *equally accessible*?
 - Yes, it is user-friendly, even for naive users, and works on the widest possible range of mobile phones (+).
 - No, it can be used only by those with specific devices and with sufficient digital education (-).
16. Is there a *decommissioning process*?
 - Yes, there is a process for shutting it down (+).
 - No, there are no policies in place (-).

4.2 Civil Rights and Fundamental Freedoms

An important aspect of ethical requirements is to protect rights and liberties:

Contact tracing via smartphone is a powerful way to tackle the spread of coronavirus, but it *mustn't be done at the expense of individual civil rights*. (Bicheno, 2020)

Is [the app] *mandatory*? How *private* is the app? Are citizens' rights being *safeguarded*? (O'Neill et al., 2020)

According to a legal opinion on smartphone contact tracing and other data driven proposals:

A de-centralised smartphone contact tracing system – the type contemplated by “DP-3T” and being considered by governments across Europe and also Apple and Google – would be likely to *comply with both human rights and data protection laws*. In contrast, a centralised smartphone system – which is the current UK Government proposal – is a *greater interference with fundamental rights* and would require *significantly greater justification to be lawful*. That justification has not yet been forthcoming. (Mat, 2020)

Any attempt to introduce ‘immunity passports’ would be a *dramatic measure, both socially and legally*. It would need a *clear scientific basis* and would also have to *address the significant impact on fundamental rights* including the *risk of indirect discrimination*. (Mat, 2020)

For instance, the designers of the NCSC app developed in the UK declared that:

[installing the app is] entirely *voluntary* (NCS, 2020)

and

You can *decide if you want to tell the app* that you're suffering from coronavirus symptoms. (NCS, 2020)

The reality, however, is often far removed from the intended properties, as the same NCSC app illustrates:

as soon as someone agrees to share their information with UK government – by claiming to feel unwell and hitting a big green button – 28 days of data from the app is given to a central server from where *it can never be recovered*. That data, featuring all the unique IDs you've encountered in that period and when and how far apart you were, *becomes the property of NCSC (...)* [The NCSC chief exec Matthew Gould] also admitted that *the data will not be deleted*, UK citizens *will not have the right to demand it is deleted*, and it can or will be *used for "research" in future*. (McCarthy, 2020)

4.3 Threats to Fundamental Freedoms

In an attempt to slow the spread of COVID-19, governments around the world are also adopting *increasingly extensive physical surveillance measures*. These include the deployment of facial recognition cameras equipped with heat sensors, surveillance drones used to monitor citizens' movements, and extensive CCTV networks in a bid to help enforce curfews. (Woodhams, 2020)

India has made it *mandatory* for government and private sector employees to download [its contact-tracing app]. (Clarence, 2020)

Using a phone's Bluetooth and location data, Aarogya Setu lets users know if they have been near a person with Covid-19 by scanning a database of known cases of infection. The data is then *shared with the government*. (Clarence, 2020)

To register, users *have to give their name, gender, travel history, telephone number and location*. (...) While your name and number won't be made public, the app does *collect this information*, as well as *your gender, travel history and whether you're a smoker*. (Clarence, 2020)

China's Health Code system, which *records a user's spending history* in order to deter them from breaking quarantine, is *invasive*. (Clarence, 2020)

Many regions that have made contact tracing a key part of their COVID-19 playbook — including China, South Korea, Taiwan and Israel — have *empowered contact tracers with sensitive details of infected people*, including CCTV footage, credit-card transactions and location data from mobile-phone carriers. (Zastrow, 2020)

several governments have also co-opted the rise of mis/disinformation to justifying *ensorship practices which seek to silence critics and control the flow of information*. (Woodhams, 2020)

4.4 Legal Requirements

UK finds itself almost alone with centralized virus contact-tracing app that (...) may be *illegal* (McCarthy, 2020)

The UK Government's announcements in March and April for sharing health data between the private and public sector appear to be *flawed*. This means such data sharing is potentially not *in compliance with legal requirements*. Further information needs to be provided to ensure compliance and a *data impact assessment should be conducted and made public*. (Mat, 2020)

the UK's own contact-tracing app *runs roughshod over regional [GDPR] regulations* and could, hypothetically, *lead to a sweeping, NHS-wide-fine* in its current state. (Wodinsky, 2020)

5 Privacy and Data Protection

Privacy-related issues for COVID-19 mitigation strategies have triggered heated discussion, and at some point gained much of the media coverage. This is understandable, since privacy and data protection is an important aspect of medical information flow, even in ordinary times:

While public-health and safety amidst the health crisis is imperative, the data rights and privacy policy responses are critical, *now, and after the crisis*. (Robertson, 2020)

Moreover, the IT measures against COVID-19 are usually designed by computer scientists and specialists, for whom technological requirements (such as information security) are relatively easy to identify and understand. As the authors of (Soltani et al., 2020) cautiously stated:

Some of the contact-tracing frameworks have been *designed with security and privacy in mind*, to some degree.

5.1 Privacy-Related Requirements

The designers of contact-tracing apps have sometimes made overly bold statements about their privacy level. Nevertheless, those indicate a general requirement that is clearly important for many users:

Any information you choose to submit is protected at all times. (NCS, 2020)

In particular:

developers of contact-tracing apps (...) should include recommendations for *how back-end systems should be secured* and *how long data*

should be retained, criteria for what public health entities can qualify to use these technologies, and explicit app store policies for what additional information, such as GPS or government ID numbers, can be collected. They should adopt commonly accepted practices such as security auditing, bug bounties, and abusability testing to identify vulnerabilities and unintended consequences of a potentially global new technology. Finally, app creators—as well as the platforms that enable these applications—should make explicit commitments for when these apps and their underlying APIs will be sunsetted. (Soltani et al., 2020)

The design is intended to mitigate privacy concerns inherent in a technological approach to identifying possible new infections, the tech companies have said. They say the apps would not collect location data or save records to a central database and would instead rely on the records saved and distributed across people's phones, which would be privacy-protected and periodically erased. (Timberg, 2020)

The app itself doesn't collect information that would obviously reveal someone's identity (Burgess, 2020)

But under data protection laws the app isn't anonymous. GDPR and the UK's data protection rules define 'personal data' as something that can identify an individual. Under GDPR, an identifier assigned to a phone can be considered personal data. (In the past a person's IP address has been ruled to be personal data). While the Bluetooth logging system in the NHS app doesn't collect location information, or other types of data, it does create an identifier (known as InstallationID) for every phone that uses the app. This counts as something that could lead to the identification of an individual. (Burgess, 2020)

"The NHSX app does not preserve the anonymity of users, as it primarily processes pseudonymous, not anonymous, personal data," Michael Veale, a lecturer in digital rights and regulation at University College London, wrote in an analysis of the NHS app. "Anonymous information is only that which is not personal data". (Burgess, 2020)

From the user perspective there is also the problem of informed consent. (Ilves, 2020)

5.1.1 Risks and Threats

Alerts can be too revealing (BBC, 2020), e.g.,

it may be possible to work out who is associating with whom from the app's ID numbers. (McCarthy, 2020)

[the data from the app] may be linked to other datasets at some point in future. (Wodinsky, 2020)

A direct exploitation of personal information is even more dangerous:

Kuwait and Bahrain have rolled out some of the *most invasive* Covid-19 contact-tracing apps in the world, putting the *privacy and security of their users at risk*, Amnesty International says. (Garthwaite and Anderson, 2020)

The rights group found the apps were carrying out *live or near-live tracking of users' locations* by uploading GPS co-ordinates to a central server. (...) The researchers say Bahraini and Kuwaiti authorities would easily be able to *link this sensitive personal information to an individual*, as users are required to register with a national ID number. (Garthwaite and Anderson, 2020)

Bahrain's app was linked to a television show called "Are You At Home?", which offered prizes to users who stayed at home during Ramadan. (Garthwaite and Anderson, 2020)

[Australian government] also has a history of '*mission creep*' regarding tracking mechanisms such as the metadata retention regime, where it allowed *citizen's data to be accessed by all sorts of law enforcement mechanisms*, contrary to initial intentions. (Robertson, 2020)

5.1.2 Reasonable Privacy

Most people accept that it might be necessary to waive users' privacy in the short term in order to contain the epidemic. However, one must look for mechanisms that impact privacy to the least possible extent.

The [Apple and Google] approach is not without risk, researchers acknowledge, but *exploiting that risk would require significant effort by hackers for seemingly little reward*. For example, they would have to turn on a different phone every time they came near a different person and wait several days to see if it reported a positive test result. (Zastrow, 2020)

Moreover, privacy-related requirements depend on the geographical and political context:

The issues uncovered by Amnesty's investigation are particularly alarming given that the human rights records of Gulf governments are poor. (...) "If privacy is violated in a country like Norway, I can resort to regional tools such as the European Court of Human Rights and European Committee of Social Rights. But in our region there is not any such tool. On the contrary, resorting to local authorities may present an additional risk" [Mohammed al-Maskati, a Bahraini activist said.] (Garthwaite and Anderson, 2020)

5.2 Data Protection and Potential Misuse of Data

Here, the key questions are:

What data will they collect, and *who is it shared with?* (O'Neill et al., 2020)

as well as

how data is collected, stored and deleted. (Robertson, 2020)

In particular, it is often postulated to have

less *state access* and *control over user data* (Bicheno, 2020)

the *limits on the type of data collection* are the core concern for states. (Tahir and Lima, 2020)

In Singapore, for example, the TraceTogether app can be used *only by its health ministry* to access data. It assures citizens that the data is to be *used strictly for disease control* and will not be *shared with law enforcement agencies* for enforcing lockdowns and quarantine. (Clarence, 2020)

[In Australia,] *Only health officials* in the states *can access the data*, and you can't be forced to download it. (Taylor, 2020)

The app does not *collect any of your personal data.* (NCS, 2020)

5.2.1 Risks and Threats

the lack of *clear privacy policies* and the use of centralised data storage increases the possibility that the *data may be vulnerable to abuse.* (Woodhams, 2020)

collection of data on centralised servers: Aside from the risk to privacy, *collecting millions of datasets of personal information in a single place could be viewed as somewhat of a treasure trove.* (Davies, 2020)

if the [central] database is hacked, the *anonymity* provided by rotating pseudonyms is nullified, and *individuals can be more easily tracked.* Plus, says Kreps, "there's a risk of *function creep* and *state surveillance*". "I have little faith in government's ability to keep data like this secure," says Green. (Zastrow, 2020)

data breaches can also come through *cyberattacks* or *independent actors within an agency* (Eisenberg, 2020)

In particular, the collected information should not be exploited for commercial purposes:

existing regulations don't address whether *data can be shared across agencies* or if it can be *sold by a third party* for non-Covid-19 tracking. (Eisenberg, 2020)

We found code relating to *Google's advertising and tracking platforms* in 17 contact tracing apps. (...) Aside from the *ethics of monetizing public health* in this way, the presence of such tracking code in contact tracing apps raises privacy red flags due to the *targeting options* offered by Google's ad platforms.

(...) We also found code that enabled *varying levels of integration with Facebook* in seven apps. This ranges from direct integration with Facebook's advertising platform to functionality allowing users of the apps to link their Facebook accounts, or to share content from the contact tracing apps to Facebook. (Woodhams, 2020)

A mistake in implementation can have serious privacy consequences in improperly tested software:

technical issues meant a person completing a form for the survey had been able to view information previously submitted by other users. (RTL, 2020b)

5.2.2 Impact on Society

Protections need to be put in place to expressly prohibit economic and social discrimination on the basis of information and technology designed to address the pandemic. (Soltani et al., 2020)

protecting those communities who can be (...) harmed by the *collection and exploitation of personal data*. (Soltani et al., 2020)

5.3 Temporal Requirements, Safeguards and Limitations, Monitoring of Privacy and Data Abuse

In this respect, an important question is:

How will that information be used in the future? Are there policies in place to prevent abuse? (O'Neill et al., 2020)

To capture this information, guided by principles put forward by the American Civil Liberties Union and others, we asked five questions: Is it *voluntary*? Are there limitations on *how the data gets used*? Will data be *destroyed* after a period of time? Is data collection *minimized*? Is the effort *transparent*? (O'Neill et al., 2020)

Among temporal requirements, sunseting is most often mentioned.

There is also a concern that the [surveillance] technology *will continue to be used after the threat of the coronavirus recedes* (Garthwaite and Anderson, 2020)

questions about privacy — including *when the tracking will be switched off*. (Scott and Wanat, 2020)

"We need *an independent state figure that's not the government who can guarantee this data will eventually be deleted*," said Arnaldo Frigessi, a professor at the University of Oslo (...)"We need to ask the questions: *When will this stop, and who will get to decide?*" (Scott and Wanat, 2020)

Any information you submit is *deleted once it is no longer needed to help manage the spread of coronavirus*. (NCS, 2020)

All the data will stay with the government for six years" (Scott and Wanat, 2020)

For example, the Norwegian app Smittestopp explicitly promised the following sunseting requirements (hel, 2020):

- data from the last 30 days are constantly recorded and *older data are deleted*
- one can *delete one's personal information* at any time
- one can *delete the app*.
- the user can also *choose whether to turn the logging features on or off*
- one has the *right to access the data* that the Norwegian Institute of Public Health stores about them.

Provisions for monitoring of privacy are also essential:

[Unlinkability] must be backed up with clear lines of *accountability*, processes for *evaluating linkage or export requests*, and *strong assurance monitoring*. (Wodinsky, 2020)

judicial oversight and *sunset provisions* (...) safeguards with respect to the privacy of data (Soltani et al., 2020)

5.4 Impact of Privacy on Health Protection

As the virus spreads rapidly, it's vital that the public *are giving the information [people] need to protect themselves and others*. (BBC, 2020)

Dr Lee says the public needs to remain mature with this information - otherwise "people who fear being judged will hide and this will *put everyone in further danger*". (BBC, 2020)

5.5 Impact on Psychological Wellbeing and Society

the government is letting people know if they were in the vicinity of a patient (...) and now there is as much *fear of social stigma* as of illness (BBC, 2020)

even if patients are not outright *identified*, they're *facing judgement - or ridicule* - online. (BBC, 2020)

A research team at Seoul National University's Graduate School of Public Health (...) found "*criticisms and further damage*" were more feared than *having the virus*. (BBC, 2020)

Doctors warn that online pursuit of patients could have very serious consequences. *Malicious comments online have long been a problem in South Korea*, and in some cases have led to *suicide*. (BBC, 2020)

5.6 Privacy vs. Epidemiological Efficiency

Much of the debate of centralized vs. decentralized design for contact-tracing apps follows the dilemma whether it is justified to sacrifice the users' privacy for the sake of efficiency in containing the epidemic:

[A centralized contact-tracing app] takes data from people's phones and saves it on a central system where experts are trusted to *make the best possible use of the data*, including providing *advice to people* as and when necessary. (McCarthy, 2020)

Some [centralized apps] store all users' interaction data on government servers that *analyse the data* and *perform the contact matching*. Proponents say that this 'centralized' model allows health authorities to use the database to *piece together a view of the network of contacts*, enabling further *epidemiological insights* such as *revealing clusters* and *superspreaders*. (Zastrow, 2020)

[decentralized contact-tracing apps:] puts users in *more control of their information*, and alerts them automatically with *no intervention from a third party*. (McCarthy, 2020)

while the (...) decentralized model *protects people's privacy*, it leaves the authorities blind. It puts a public health disaster outside the reach of those who can *help most thorough analysis of the population*. (McCarthy, 2020)

Health experts are less in favour of [the decentralized] model because it makes it harder to *spot outbreaks* and is harder to *follow up for close contacts*, but privacy advocates insist it is the most *secure*. (Taylor, 2020)

5.7 Privacy in Support of Epidemiological Efficiency

As we have seen in Section 5.6, there is a tradeoff between protecting privacy vs. collecting and protecting all the information that can be useful in fighting the epidemic. The relationship is not that simple, though. Privacy provisions are instrumental in building trust. Conversely, lack of privacy undermines trust, and may weaken the epidemiological, economic, and social effects of the mitigation activities.

Privacy fears *threaten* New York City's *coronavirus tracing efforts* (Eisenberg, 2020)

the de Blasio administration's *unwillingness to specify* how privacy will be protected will *limit the tracing effort's reach* and potentially *prolong the need for strict lockdown* (Eisenberg, 2020)

[Manual] Contact tracing relies on a city worker building *trust* with a Covid-19-positive person, who then details where they've been and with whom they've been in contact prior to the onset of symptoms (...) Contact tracing requires handing over intimate personal data — including home addresses, names of friends and relations — to strangers, many of whom were only recently trained and hired to collect the information. (Eisenberg, 2020)

Hundreds of thousands of New Yorkers will be asked to disclose personal information this month as part of the city's herculean Covid-19 tracing effort — but *suspicious over how the government will use that information* are threatening the city's best chance to *crawl out of its coronavirus lockdown*. (Eisenberg, 2020)

"I did already hear rumors in Yiddish that they shouldn't answer the [contact tracing] calls," said Yosef Hershkop, manager of Kāmin Health Crown Heights Urgent Care. "There's no way they're going to *get* any more *cooperation* from the Jewish community than the African American community or Arab community or Muslim community. Everyone is *suspicious*." (Eisenberg, 2020)

6 User-Related Aspects

The measures must be adopted and followed by the people, in order to make them effective.

6.1 User Incentives

The design, implementation and adoption of complex socio-technical systems must be *driven by the interests of users*. (Robertson, 2020)

Ultimately, contact tracing (...) can reduce the spread of disease through the population, but does not confer direct protection on any individual. This creates *incentive problems* that need careful thought: *What is in it for the user* who will sometimes be instructed to miss work and avoid socializing, but does not derive *immediate benefits* from the system? (Soltani et al., 2020)

A poll published last week by the Kaiser Family Foundation found the nation similarly split on *willingness to use* an infection-alert app but found much *higher rates of acceptance* — with 2 out of every 3 Americans willing — when they were told the technology was seen as *assisting in opening schools and businesses* and *helping revive the stalled national economy*. But fewer than 3 in 10 were willing to use an app if there was a “chance the data could be hacked.” (Timberg, 2020)

The government (...) didn't exclude mandatory downloading [that] stands in stark contrast to the 'smart lockdown' with *strong reliance on personal responsibility* (Stollmeyer et al., 2020)

Won't this tool *divert attention from more important measures*, and *make people less alert*? (Szymielewicz et al., 2020)

even with a very accurate test, the fewer people in a population who have a condition, the more likely it is that an individual's positive result is wrong. If it is, people might think they have the antibodies (and thus may have immunity), when in fact they do not. (Frasier, 2020)

6.2 User Experience

Since the app was released in mid-March *people's experiences have varied*, with many willing to give up their personal information to help reduce the number of overall infections. Most said the app is *prone to failure*, not a surprise as the Polish government created it in just three days based on an out-of-the-box service offered by a third-party developer. (Scott and Wanat, 2020)

Interoperability is an important aspect of user experience, so that:

Users of contact tracing and warning apps can now *use a single app* when they travel cross-borders and still benefit from contact tracing. (O'Donoghue and Bialowas, 2020)

This means a user of one of those apps who travels to any of the other countries can expect their national app to send relevant exposure notifications in the same way it should if they had not travelled — *without the need to download any additional software*. (Lomas, 2020)

6.3 Adoption and Its Impact on Other Requirements

The aspects indicated in Sections 6.1 and 6.2 have impact on adoption of the strategy:

How many people will *download and use* [the apps], and how widely used do they have to be in order to *succeed*? (O'Neill et al., 2020)

Another challenge is ensuring that *enough people download the app to make it effective*. (Zastrow, 2020)

For example, it was reported in (Bezatz, 2020) that only 2% of people in France installed the app as of 10/06. This has important consequences:

Reduced adoption [of the app] could limit its *effectiveness in slowing new infections and deaths*. (Timberg, 2020)

The Oxford models³ found that "the app *has an effect* at all levels of uptake" (...) The paper says that if 80% of all smartphone users download the app—a number that excludes groups less likely to have a smartphone and is equivalent to 56% of the overall population—this would be enough to *suppress the pandemic* on its own, without any other form of intervention. (O'Neill, 2020)

if fewer people download the app, say the researchers, *other prevention and containment measures will be required*. These include social distancing, widespread testing, manual contact tracing, medical treatment, and regional shutdowns (O'Neill, 2020)

Trust is an important issue (see also the connection between privacy provisions and trust in Section 5.7).

For people to use the app, there *needs to be trust*. (Burgess, 2020)

[J.T. Lane, chief population officer at the Association of State and Territorial Health Officials:] "You need to learn everything you can about [the users'] culture and maybe even their previous relationship with technology," Lane said, including "how stigma and discrimination might be playing a role in that particular group or culture." (POL, 2020)

[Approach of] blending technology with manual contact tracing, solves two key problems with contact tracing apps: trust and efficacy. *Trust is a key foundation of public health* and a big problem for contact tracing apps; (...) research shows that people are divided on *whom they trust to provide the apps* as well as whether *they trust the apps to actually work and to protect their data*. (Redmiles, 2020)

³Hinch et al. (2020)

7 Technological Requirements

The concrete measures have to *work*, in the most basic sense of the term.

7.1 Basic Requirements

First of all, this means that the design correctly addresses the desired functionalities, the implementation is correct with respect to the design, and the measures have an acceptable level of usability.

UK finds itself almost alone with centralized virus contact-tracing app that *probably won't work well*, asks for your location, may be illegal (McCarthy, 2020)

According to local reports from folks that have downloaded the program thus far, not only is the app *incompatible with a range of different devices*, but it's also a *battery-draining* mess that can be *confusing to use*. (Wodinsky, 2020)

Beyond concerns over privacy, one key practical challenge to phone-based contact tracing is *making accurate measurements* of how close two devices are. (Zastrow, 2020)

7.2 Transparency

Moreover, the design and the implementation should be sufficiently transparent.

The forthcoming challenge for the Australian government is to be *open* and *transparent* about the app's privacy implications. (...) the public deserved to be *fully informed about the cyber security implications*. (Robertson, 2020)

It's essential to see *transparency* around *encryption methods used by the app*, *the potential blue tooth (sic) vulnerabilities related to the collection of data*, and *how access to the data by state and territory health officers will be audited*. (Robertson, 2020)

Covid Tracing Tracker puts forward a number of “basic questions” related to the transparency of the design and implementation:

Who is producing [the app]? Is it released yet? Where will it be available, and on what platforms? What technologies does it use? (...) how many people have downloaded it and what level of penetration it has achieved. How *transparent* are the makers about their work? (O'Neill et al., 2020)

Other important aspects that help to build trust in digital solutions are: *transparency of the code* and the possibility to *verify the code* by the public and experts (SDZ, 2020), see also this quote on the Australian Government's COVID-Safe application:

The code is *not publicly available* and open-source data is *stored on private, cloud-based web servers*, which provides a *honey-pot for cyber-attacks* on this highly sensitive information about the population. (Robertson, 2020)

7.3 Interoperability

An important technical goal that demands international cooperation in early design phases is *cross-border interoperability*.

Many [EU] member states have implemented *national* contact tracing and warning applications. It is now time to make them *interact with each other*. (Staff, 2020)

The goals include relaxation of the economic and social restrictions, as well as coordinated data protection:

In time, this will *simplify cross-border contact tracing and allow our people to visit our neighbours for work, trade or leisure*. (Cyb, 2020)

This *coordinated approach* will also help to ensure that *the same level of data protection is given to users [across EU]*. (O'Donoghue and Bialowas, 2020)

Interoperability-related requirements concern data flow, efficiency, and privacy:

Each [national] backend communicates only with the gateway, so you don't have a direct exchange between the different backends. (...) And that *keeps the data flow to a minimum* and is much more *efficient*. (Kobie, 2020)

No other information than arbitrary keys, generated by the apps, will be *handled by the gateway*. (...) The information is *pseudonymised, encrypted, kept to the minimum and only stored as long as necessary* to trace back infections. It *does not allow the identification of individual persons*, nor to *track location or movement* of devices. (Lomas, 2020)

Risks and threats:

Ensuring interoperability is *technically difficult* and may *require changes to existing national apps*. (O'Donoghue and Bialowas, 2020)

Run from the European Commission's data centre in Luxembourg, the system was designed by SAP and T-Systems, using a (...) *third-party server* dubbed a "gateway" to let [EU] member countries' apps share data. (Kobie, 2020)

As with the national contact tracing app and user adoption

The effectiveness of this interoperable gateway will depend on how many [EU] Member States register their national contact tracing apps with this new service. (O'Donoghue and Bialowas, 2020)

8 Evaluation and Learning for the Future

COVID-19 mitigation activities should be subject to rigorous assessment. Moreover, their outcomes should be used to extend our knowledge about this and similar pandemics, and better defend ourselves in the future.

8.1 Evaluation-Related Requirements

Systematic evaluation of the adopted solutions is itself a requirement:

"After the spread of virus ends," [Mr Goh, from the Korea Centers for Disease Control Prevention] says, "there has to be *society's assessment whether or not this was effective and appropriate.*" (BBC, 2020)

A *review and exit strategy* must be in place to establish when and how fast this should happen. These *assessments* should be *conducted by an independent body*, such as a regulator or an ethics advisory board, and *not by the designers or the government itself*. Circumstances and attitudes are changing quickly, so the questions (...) must be *asked anew at regular intervals.* (Morley et al., 2020)

Evaluation and assessment is bound to be multi-dimensional and complex:

Before rolling out any app, the EU needs to do a *coordinated assessment of usefulness, effectiveness, technological readiness, cyber security risks and threats to fundamental freedoms and human rights.* (Stollmeyer et al., 2020)

it's difficult to *determine the effect of app use in combination with* early and extensive testing, the massive wearing of face masks and strict enforcement at physical distance. (Stollmeyer et al., 2020)

8.2 Learning for the Future

Last but not least, we need to building scientific knowledge, and learn how to better fight pandemics in the future.

Anonymised data on movement patterns of the population collected by the app are also supposed to be used to *develop efficient infection control measures.* [They] will be used to *gain insight into the effect of changes to the measures for fighting the virus.* (hel, 2020)

9 Conclusions

In this report, we make the first step towards a systematic analysis of strategies for effective and trustworthy mitigation of the current pandemic. The strategies may incorporate medical, social, economic, as well as technological measures.

Consequently, there is a large number of medical, social, economic, and technological requirements that must be taken into account when deciding which strategy to adopt. Being computer scientists who specialize in information security, we find the latter kind of requirements most obvious, especially with respect privacy and security of information flow. This is exactly the pitfall that computer scientists must avoid. It is essential to realize that the goals (and acceptability criteria) for a mitigation strategy are much more diverse, and consciously choose a solution that satisfies the multiple criteria to a reasonable degree.

In a forthcoming companion paper, we will present a digest of the requirements, derived from the news clips, and a preliminary take on their formal specification.

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