Starting with SOAP: rapid deployment of contact tracing technologies in a pandemic

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Foreword

At the beginning of April, researchers from disciplines across the **Australian National University** and partners began discussing ways of evaluating the variety of contact tracing technologies being deployed, or in the process of being deployed, by countries as part of their response to COVID19 outbreaks.[1] Over the course of the month, debate surrounding potential contact tracing technologies has intensified. Growing public awareness of the ways in which data about people has been misused and abused by public and private sector organisations in the past makes trust in any contact tracing technology that citizens are encouraged to use hard to secure. Questions about how and when to relax social distancing precautions persist. Discussions are becoming increasingly polarised. Sometimes, it's no longer clear we still ultimately share a common goal: improving contact tracing.

Public health officials have used contact tracing during disease outbreaks for nearly a century. "Contact tracing" comprises a range of techniques to identify, evaluate, manage and ultimately contain an outbreak. As such, contact tracing is part of a broader system of public health activities, that often include testing regimes, medical treatment and quarantine practices, as well as standards and rules prescribing how contact tracing occurs.

It stands to reason, then, that every technology implementation supporting contact tracing will also be part of that wider system - comprising people and technologies and processes and extraneous impacts - working to contain a disease outbreak. The speed at which we need to

[1] A number of websites are maintaining registers of contact tracing technologies in deployment, or in the process of being deployed, in countries including Singapore, Taiwan, Israel, the United Kingdom and Ireland. Wikipedia has a regularly updated list at: https://en.wikipedia.org/wiki/COVID19_apps#List_of_apps_by_country. On 14 April 2020, Australian Prime Minister confirmed the federal government would be releasing its own contact tracing app based on the Singapore Government's TraceTogether solution.

respond to new cases and reduce the risk of further transmission of COVID19 necessitates moving quickly. At the same time, we must be cautious and clear-sighted about the ways in which any new technology implementation could actually make existing contact tracing practices harder.

Deploying any contact tracing technology at scale, with high stakes, means weighing multiple considerations. A technology may be perfect or near-perfect preserving an individual's privacy, but integrate poorly with a government authority's existing testing, monitoring or contact tracing methods. It may greatly improve existing contact tracing methods, but expose detailed information about individuals in ways that might ultimately harm them. It could both safeguard privacy and integrate with existing contact tracing methods used by authorities, but fail comprehensively as a straightforward, easy to use app for citizens that gives them control over how and when they engage, and when they stop engaging. It could neglect to take into account those people who don't have smart phones, or don't always carry them, or are not active users of them.

Our aim is to create space for discussing and evaluating potential contact tracing technologies according to several criteria, exposing relationships between key concerns and priorities across groups engaged in the debate. These include: the extent to which technologies supporting contact tracing preserve individual or community **privacy**; the extent to which they're **secure** from malicious or inadvertent misuse; how suitable they are for **operational use** as part of a health authority's response to an outbreak**;** and the extent to which **assurance** of that technology - validating that it is working as intended - is possible.

We've come up with a simple evaluation method called the **SOAP method.**[2] It's designed to broaden conversations, and help decision makers, health authorities looking to augment contact tracing with more technical tools, and people affected by contact tracing technologies, consider a range of factors that shape the design of a technology solution, and the effects that solution could have on contact tracing practices already in place. We've called it SOAP because we think this kind of sense checking exercise should be **standard hygiene practice** for anyone designing and deploying, or discussing, digital contact tracing technologies as part of an outbreak response.

[2] Note: our method bears no connection with the SOAP protocol for web services, other than a great acronym.

SOAP is structured around four concepts. Each concept is discussed in detail in the white paper. The four concepts are:

S **How secure is this solution?**

O **How does it support operational use, and by who, during a pandemic?**

A **How will its effectiveness be assured?**

P **How is the privacy of individuals - both in proximity to confirmed infected persons, and infected persons - preserved?**

SOAP alone is not supposed to be a panacea. Neither is its namesake, hand soap. SOAP is a simple, habitual practice designed to support safe, responsible and sustainable technology solutions. Pausing briefly to reflect on any intended deployment of tracing technology using SOAP, and the variety of concerns and needs it encompasses, can help make sure there are no glaring problems or contradictions that have been missed in its design, or which could adversely affect the people it's supposed to help if not addressed.

SOAP has been designed with support from researchers across the ANU, including computer scientists, cryptographers, legal scholars, epidemiologists, philosophers, data analysts, user researchers, anthropologists, engineers and social scientists. The technical, social, legal and contextual considerations it includes reflect the practicalities - and complexities - of designing and deploying technology solutions. These decisions cannot be left to one discipline, or one frame of reference. Ultimately, while the contributors to this document span a range of disciplines, we share two common goals: supporting contact tracing during a disease outbreak with responsible, safe technologies where it makes sense to deploy them; and ensuring citizens can trust that any technologies being deployed cannot and will not be used in ways that ultimately harm them.

Openness and Transparency

In the absence of transparency about information being used to make decisions during a pandemic, disinformation flourishes. Armchair experts, malicious actors and well-meaning people with only half the story can contribute confusing and contradictory narratives.

Trust in how public and private organisations use data collected from people is already low. During a pandemic, maintaining trust in decisions made by public health authorities in governments is essential to maintaining public health advice compliance. Confusing and contradictory narratives about contact tracing technologies, in the absence of any real information, exacerbate public concerns.

This is why openness of any contact tracing solution being proposed, from the very beginning of the process of deployment is essential. Communication must be informative, honest and willing to adjust based on public feedback. Without upfront investment in open communication, any technology solution could fail to win public support before it's even released, irrespective of its actual design and intention.

For any discussion about technologies supporting contact tracing to be productive (and ultimately improve the likelihood that that technology will work as intended) evaluations, modelling, code, privacy and security assessments and anything else informing the design and deployment of that solution must be published and licensed under an open licence where possible. SOAP requires transparency of software, and evaluations informing the development of that software as part of its 'A - assurance' - concept. Open and honest communication is essential to retaining community trust.

Using SOAP to rapidly assess contact tracing technologies

There are a range of ways in which technologies are being deployed to enhance contact tracing: using digital sources of information to enhance contact tracing interviews with confirmed infected persons; supplementing in-person interviews with Bluetooth-enabled proximity tracking (i.e. the Singapore Government's TraceTogether app, COVID Watch, DP-3T); as well as back-end support, like shared cloud-based infrastructure for rapidly collecting COVID test results from a network of testing centres.

In this white paper we focus specifically on technological interventions to help improve the process of contact tracing with citizens, and questions and criteria to guide their deployment.

How does contact tracing work?

We have observed a rise in detailed technology solutions augmenting or, in some cases, entirely automating contact tracing that do not explicitly articulate the goals and needs of contact tracing.

Contact tracing is a core component of any public health response to an outbreak. For any outbreak, identifying confirmed infected persons and tracing and quarantining people they have been in close contact with becomes essential. Noting the highly contagious nature of COVID19 and in the absence of a vaccine or effective treatment for COVID19, contact tracing is even more crucial. Contact tracing infected persons before they are able to transmit the disease to others helps epidemiologists break chains of transmission.

For contact tracing to be effective, epidemiologists need to be able to:

- Rapidly and comprehensively identify all people an infected person has been in close contact with;
- Quarantine each of those contacts, and monitor them for signs of infection; and
- Trace each new confirmed infected person to a person they have come into contact with, from whom they acquired the infection. An infected person who cannot be traced to another known or confirmed infected person suggests that they may have acquired the infection in the community (called 'community transmission', an important public health indicator measuring severity of the outbreak).

In Australia, laboratory test results for each confirmed case of COVID19 are shared with the diagnosing general practitioner and the local public health authority (depending on processes within each state/territory jurisdiction). Pathology services use methods to transmit test results considered to be secure within the sector, including fax or service/network specific secure databases. As COVID19 is a notifiable disease, the notification processes are in line with Australia's National Notifiable Disease Surveillance. Public health practitioners then conduct an over the telephone interview with confirmed infected persons to determine how they acquired

the disease, and seek information about other individuals they may have come into contact with. All of those contacts who are considered to be a 'close contact' of an infected person, based on a defined criteria, are then followed up by contact tracers.

These contact tracers include trained public health experts, epidemiologists, public health students, nursing students, medical students, or retired healthcare workers. Case and contact investigation files are created, capturing a range of demographic and recent history of infected persons and their contacts. While the identity of an infected person (their name) is not essential and never revealed, demographic information is. Where a person is infected, demographic details can help epidemiologists study effects of the disease and potential risk factors. Demographic information about people an infected person is in contact with helps epidemiologists monitor people most likely to develop the disease, or who are particularly vulnerable to it (e.g. knowing that a location the confirmed infected person visited was an aged care home, and on what day - prior to the confirmed test result - and that they were visiting their 87 year old grandmother who has diabetes).

Clinical care, as well as establishing and breaking chains of transmission, is an important part of contact tracing. Epidemiologists are trained to provide information to infected persons and people they have been in contact with about identifying and providing information on disease symptoms, and when and where to get tested, and what to do if symptoms develop. Often, people who are notified that they have been in contact with an infected person have questions about their own or their family's susceptibility to the disease. Contacts are monitored for 14 days to determine whether they develop symptoms of the disease. This ongoing monitoring of contacts may involve telephone calls or daily text messages with links to surveys, asking them to check their symptoms. It may rely on contacts to notify the health authority should they develop symptoms.

The process of interviewing cases, determining contacts, and monitoring contacts is time consuming. People can have poor memory recall. Identifying and isolating symptomatic and presymptomatic individuals are key to limiting transmission. Being able to connect each new confirmed infected person with another infected person they were in contact with is essential for epidemiologists to understand the extent of community (unexplained) transmission.

COVID19 is not the first disease outbreak to have involved the use of contact tracing technologies. In some contexts, phone applications supporting contact tracing are described under the umbrella term, 'mHealth'. During the 2014 Ebola outbreak in West Africa, contact tracers used mobile devices to collect data during contact tracing interviews; SMS to communicate with quarantined contacts; and experimented with Bluetooth. Contact tracing technologies have also been used to support contact tracing for TB, as well as surveillance of complex TB treatment adherence.

Some areas in which greater use of digital tools has been discussed to improve contact tracing during COVID19 include:

- Helping an infected person recall their own movements and contacts over the past 14 days, especially during non-social distancing life when an average person may come into close contact with approximately 10 people per day.
- Speeding up the process by which contact tracers get in touch with an infected person's contacts
- Automating monitoring of contacts for signs of transmission of the disease

Discussions with epidemiologists have indicated that:

- Consistent and rapid diagnostic testing is essential for any enhanced digital contact tracing tools to be effective
- Contact tracing tools must enable them to reliably identify chains of transmission between infected people
- Ensuring that contacts of an infected person are well and are in self-quarantine to minimise spread remains a foundational part of contact tracing and a public health responsibility, and are unlikely to be replaced completely by digital solutions.

Starting any contact tracing technology discussion with SOAP

In this white paper, we've begun articulating high level criteria and questions to frame discussions of a proposed contact tracing solution. We don't prioritise one technological approach to contact tracing (for example, decentralised Bluetooth-based proximity tracking). Ultimately, the most effective technology approach will be context specific, and based on the part of the contact tracing process the technology is supposed to improve.

Define your purpose

We strongly recommend that, prior to working through SOAP, decision makers and people trying to understand the scope of a contact tracing solution seek a clear statement of its **purpose. What is it intended to support? In what context will it be deployed?**

Purpose should be clearly expressed and measurable. "Improving contact tracing" is not sufficiently clear. The described purpose of a technology solution should make clear the element of existing contact tracing processes that solution is designed to complement or improve, and how it will do so. This may be presented as a statement of requirements or user needs.

TraceTogether, the Singapore government's app, for example, is intended to help public health authorities get in mobile phone contact with people who have come into contact with an infected person, via Bluetooth signals users of the app exchange with each other when in physical proximity for a prescribed length of time. Data about devices in proximity remains on a user's device unless that user tests positive for COVID19. Then, should they wish to, they grant the Ministry of Health access to their TraceTogether data. The Ministry of Health uses this information to contact by phone every other TraceTogether user who has been in prolonged proximity to that infected person. Their goal is to make the process of reaching out by phone to people who have been in prolonged proximity to an infected person faster.

Not all technology solutions involve apps on peoples' phones. NextTrace, for example, a project led by Trevor Bedford at the Fred Hutchinson Cancer Research Center, aims to deliver a digital survey-based contact tracing platform to be deployed by public health officials in the United States. Rather than an app for individual citizens to download, it's a platform supporting public health officials to administer surveys online. Citizens are encouraged to look through apps on their phone or other sources of digital information that might help them complete the survey.

Framing conversations and questions with SOAP

In version one of this white paper, we have begun capturing high level criteria any solution should satisfy, and questions to guide decision makers, experts and the general public. This is a starting point for further discussion. Our aim has been to make explicit interdependent considerations informing contact tracing technology design.

What is missing from this white paper is a way of measuring these concepts. We have purposely avoided using the language of 'trade offs', which suggests one concept could be traded away in full for another. Every concept is important and involves varied expertise. How we balance these concepts, to achieve some equilibrium, is the follow up research question to be explored. We will also expand on criteria with examples of best practice emerging around COVID19, and from other sectors, as part of creating a formal evaluation framework.

S **How secure is this solution?** *How is the confidentiality, integrity and availability of this system, its applications and information being managed? For contact tracing solutions, security requirements do not just focus on information transmitted or at rest between systems. Public authorities need to be sure of the integrity of that system (e.g. that it is not vulnerable to manipulation using false COVID tests, or false contact movements); and that it is consistently available (accessible and able to be relied upon by its users).*				
Criteria for any solution[3]	A security and risk assessment has been conducted[4]	A process is in place for identifying and responding to cyber security risks	Confidentiality, integrity and availability requirements have been determined and documented	Information communicated between systems is controlled, inspectable and auditable
Some questions to ask **In a future version of the SOAP framework we will develop weights for these question, to support measurement of risk**	Can someone falsify their COVID19 status within the app, and how easily?[5]	Can someone falsify their individual movements, and how easily?	How easily could the solution be brought offline, and what impact would this have?	Could data collected or generated by this solution be intercepted by other actors?

[3] This is a short selection from the Australian Government's Information Security Manual https://www.cyber.gov.au/sites/default/files/2019-10/Australian%20Government%20Information%20Security%20Manual%20%28October%202019%29.pdf

[4] E.g. IRAP in Australia https://www.cyber.gov.au/irap/irap_assessments

[5] See e.g. concerns with the UK NHS Bluetooth solution relying on self reporting by individuals https://www.theguardian.com/uk-news/2020/mar/31/nhs-developing-app-to-trace-close-contacts-of-coronavirus-carriers

O How does it support operational use, and by who, during a pandemic?

Often there are several users of any contact tracing solution, who either provide information directly through the solution or whose work is impacted by it e.g. individual citizens, providing information for the purposes of contact tracing; epidemiologists undertaking contact tracing, and testing centres confirming test results. Ultimately, any technology solution must support and engage with its users if it is to complement contact tracing. A failure to work in lockstep with intended operational use at best will have little effect; at worst it will make existing contact tracing methods slower

Criteria for any solution	Epidemiologists and citizen users have been consulted on the design of the solution	User needs and profiles have been clearly documented	User testing commensurate to the scale of the solution has been undertaken and assessment drafted	Gaps, adverse impacts, risks and feedback loops have been clearly documented and addressed
	Vulnerable communities, who may not be able to engage with a technology solution, have been clearly identified and alternatives offered			
Some questions to ask **In a future version of the SOAP framework we will develop weights for these question, to support measurement of risk**	How much did you engage epidemiologists in this?	Has it gone through user testing?	What changes have been made following user testing?	Who will not be able to use it, and what impact will that have?
	What other systems associated with disease outbreak monitoring does it rely on? (e.g. testing)	How does this fit in with existing contact tracing?	How do you encourage and train people to use it?[6]	How do you know if it's not working?

[6] A carefully designed contact tracing solution, that preserves privacy and security to a degree satisfactory to the general public and expert contributors, and which supports operational delivery, could and should be used to make existing contact tracing processes more efficient. While this white paper does not express a view as to how uptake should be encouraged, but does observe the role of incentives e.g. tying use of the app to a partial immunity from social distancing fines (in the event of an inadvertent or low risk breach).

A **How will its effectiveness be assured?** *Without assurance, organisations deploying contact tracing technologies may never know whether they actually improve contact tracing. Worse, they may never know whether their implementation is negatively impacting contact tracing, or introducing new challenges they failed to consider. Setting benchmarks for measuring success, creating mechanisms to test and validate that implementation, and creating feedback loops for users of the solution (public health officials and users) are essential to making sure any contact tracing solution is still working as intended.*				
Criteria for any solution	Software code, assessments and results of testing are open and reviewable	Indicators of success are clearly stated and measurable	Auditing methods clearly defined and in place	Support for ongoing feedback, maintenance and enhancement of the solution is provided
	Regulator or other decision making body with responsibility for authorising and auditing contact tracing technologies, where they involve personal information, has been identified			
Some questions to ask **In a future version of the SOAP framework we will develop weights for these question, to support measurement of risk**	Who is in charge of this solution roll out and service delivery?[7]	What will you do if it's not working?	Is there a process in place for changing or winding down this system if it's not working?	Who bears the loss if the solution negatively impacts members of the public? E.g. facilitates discrimination
	How do you know when it's working?	How are you gathering feedback from users and experts about this system?	How will groups not exposed to the solution, who should benefit from it, be engaged?	

[7] If private actors roll out a government technology service, contracts will determine the extent of liability that provider holds for service failure. The contract will be a useful tool to (i) allocate risk and liabilities; (ii) dis-incentivise data misuse and (iii) provide certainty around rights and obligations. Safeguards to preserve the interests of members of the public will be required in that contract, as members of the public will not be able to sue the provider directly on the basis of that contract.

P **How is the privacy of individuals and communities preserved?**

Privacy is a concept with a range of definitions, for different people, and for different cultures.[8] Preserving privacy is both a technical, legal and social consideration, and the ways in which we navigate privacy are context specific. The extent to which potentially sensitive and personally identifiable information is provided by individuals (or communities) during a disease outbreak will vary based on the purpose for which information is being collected, who is collecting it, and how it will be used. In contact tracing, trust in the public health practitioner is essential for confirmed infected persons to accurately disclose their movements, contacts and demographic factors that may help manage their experience of the disease. Contact tracing technologies deployed at scale - e.g. on personal devices - expose risks to individuals, and to communities from whom common patterns of interaction might be identified.

Criteria for any solution[9]	**Gaining consent**	Purpose for which the system is being used is clearly communicated to individual, and consent is freely given	Data that is collected via the digital tool is explained explicitly to individuals, supported by an explanation of the effects of disclosure	Disclosure of personal information to any digital tool by individuals is **voluntary and freely given**
	Legal safeguards irrespective of consent[10]	Legal safeguards prevent reuse of personal information for any purpose other than purpose communicated to user	Legal safeguards prevent uptake of the solution by coercion	Legal safeguards prohibit uses of data provided by individuals (e.g. for advertising or other government compliance) irrespective of consent

[8] Altman I 'Privacy Regulation: Culturally Universal or Culturally Specific?' Journal of Social Issues, Volume 33, Number 3, 1977.

[9] One topic of substantial internal debate was whether criteria should expressly prohibit certain technical implementations, e.g. any centralised solutions providing health authorities with data collected from citizens or derived from devices. We would like to further explore the relationship between centralised and decentralised technical solutions, and the express purpose public authorities seek in deploying a solution, before setting further hard constraints.

[10] See, for example, Professor Lilian Edwards' and contributors model statute proposing safeguards for contact tracing technologies https://osf.io/preprints/lawarxiv/yc6xu/

	Building for consent and safety	A sunset clause prevents further use of data after a certain date, which is reflected in the technical design of that system where possible[11]	Real mechanisms exist to confirm that data is being stored and used only for express purpose for which consent is granted	A clear timeline for closing down the service is stated and mechanisms for confirming it has been closed down proposed
Some questions to ask **In a future version of the SOAP framework we will develop weights for these question, to support measurement of risk**	What information exactly is collected through this tool, and what information is it added to?	How does the tool impact the privacy of individuals who are not users of that tool, but eg. share a relationship with people who do?	Did you test consent language and comprehension with real people?	How easy is it for users of this solution to identify other individuals using the solution?
	How easy is it for individuals using this solution, or the public at large or malicious actors to identify infected people?	Have the needs of marginalised and at risk communities from misuse of this data been considered?	Can people remove themselves from the service and delete their data?	What are the **downstream effects** of this solution? Does it create infrastructure that could be used for adverse purposes in future?

Next steps: creating a formal evaluation method using SOAP

This document simply provides an introduction to SOAP. It's designed to encourage discussions regarding contact tracing technologies to engage with a broader range of considerations, and start to explore interdependencies and inconsistencies between solutions currently being proposed. In future versions of this framework, we are exploring:

- Creating a formal evaluation method, refining criteria by which technology solutions might be considered and assigning weights to each. Where aspects of a solution are negatively weighted, mitigation actions might be proposed
- Turning a high level SOAP overview into a visual communication tool

[11] Note: a form of legal guarantee may be required.

- Creating guidance and training to support organisations bringing together related and interdependent perspectives shaping contact tracing technologies

Who can use SOAP

- Anyone tasked with designing and deploying a tracing technology solution: a government agency, a technology company, developers keen to engage in solutions to support COVID19, and academic institutions.
- Anyone reporting on emerging tracing technology solutions
- Members of the public wanting to more critically engage with a proposed contact tracing solution

Who needs to be involved in SOAP discussions

The four concepts SOAP invokes reflect a range of perspectives from colleges across the Australian National University. Responding to these concepts requires insight from epidemiologists, security and privacy experts, public health officials, legal scholars, user experience designers, systems engineers, computer/data scientists, community-based organisations, patient advocates and community advocates, and social scientists.