Google/Apple Exposure Notification Framework (APIs) Discovery – May 2020

What are Google and Apple introducing?

Phase 1

On 20 May 2020, Apple and Google introduced new 'exposure notification APIs' to overcome current limitations in Bluetooth capability on devices, particularly iOS background limitations. They will also use this API to handle the encounter tracking and exposure notifications on behalf of public health authorities globally.

Phase 2

Over the coming months, Google and Apple will be making changes to their underlying OS to include exposure notification capability as a native functionality. This means users will not necessarily need a Government contact tracing app on their device to be notified of a close contact, although it is encouraged for individuals to have a government app for further support and information, and to upload their data if they are confirmed positive with COVID-19. We expect this will be released in September.

Source: Apple Google exposure notification API frequently asked questions v1.1

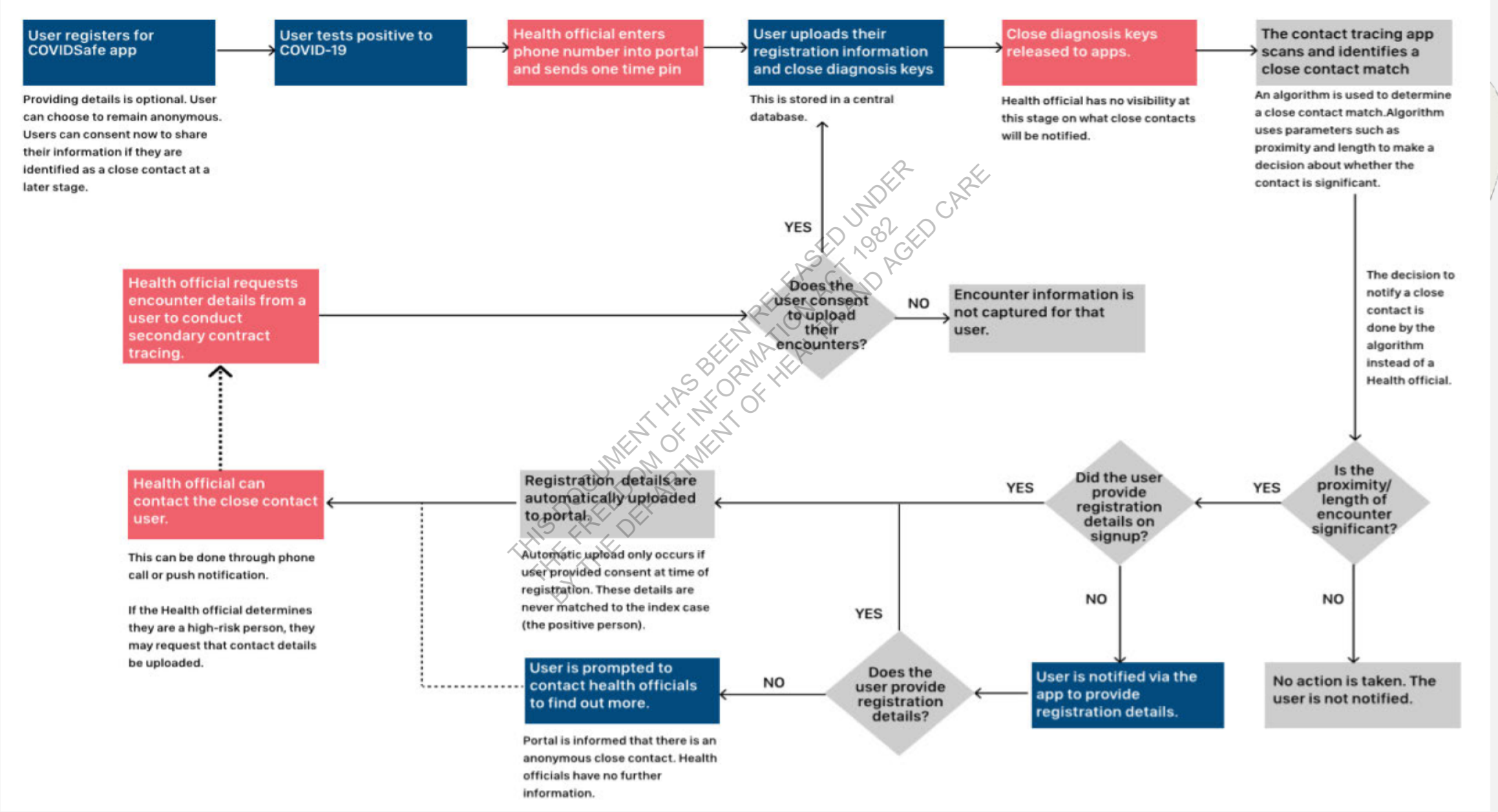
Four options to consider

Options	1 No change	2 Integrate or refactor app with ENF	3 Integrate/refactor app w/ ENF Australian specs remain	4 Parallel run current app & build separate new ENF compliant app
Overview	Maintain and enhance current app & portal. Do not adopt ENF	Change/integrate current app with ENF	Maintain current app & portal + liaise with Google / Apple to adjust ENF specs/policies to work with Australia	Maintain current app & portal + build a new ENF compliant app
App	Keep	Keep & Integrate	Keep & Integrate	Keep for current & build new
Portal	Keep	Keep only for upload of positive case	Keep & integrate	Keep for current
Bluetooth	Keep	Remove	Remove	Keep for current
Gapple APIs & OS	Ignore	Adopt	Adopt	Adopt for new
Legislation	Keep	Change	Keep & minor modifications	Change

Key points of current Australian centralised model

- Australia has responded to the coronavirus pandemic by emphasising increased testing, improved contact-tracing and rapid response to cells - addressing breakouts from a point perspective rather than through country-wide measures.
- COVIDSafe has been designed to augment the public health response in which health officials takes responsibility for contacting close contacts. That decision was made in consultation with epidemiologists. Health Officials talk to people, apply a risk framework based on the circumstances and advise on next steps. The lack of notifications between phones was a conscious decision because of the risk assessment process that health officials need to undertake to contact trace.
- Pool of test data is small but could increase with easing of restrictions here.
- We'll continue to tune the outcome. State and Territory Chief Medical Officers are working with epidemiologists to learn how the disease is working - e.g. different age groups who are spreaders. In the clusters that we get, at what point is the disease most transmitted, Based on these learnings, we may decide that a close contact is anyone who was in contact with the positive case two days before symptoms appeared.

Simplified ENF Model Diagram



(Detailed Version in Appendix)

How does this compare to COVIDSafe and Australian requirements?

- Currently users must register to use the app. Under ENF users can choose to stay anonymous. Health Officials can only see their details if the user has chosen to provide it on registration, or consents to share it once notified they are a close contact.
  - While registration is optional when users first launch the app, we can prompt users to voluntarily provide this information when they next launch the app.

- Currently close contacts are matched to a person who tests positive. Under ENF, close contacts are never matched to a positive case.

- Currently Health Officials manually determine who is a close contact. ENF automates this risk assessment through parameters in the algorithm that is hosted on the local device level (that we can set). There is no discretion to make calls on risk on individual basis.

- Currently Health Officials call users to inform them that they are a close contact. In the new model, users could be notified through a system notification or a phone call from a Health Official (where users have provided their phone number).

Key Benefits of the ENF Model

- **Bluetooth Connectivity Improvements:**

The major benefit of ENF is the promised Bluetooth connectivity improvements. While Apple/Google have represented this improvement to us, we have been unable to validate these claims and compare them to the Bluetooth improvements we have already made. The ENF does not surface information about Bluetooth performance to our developers in a way that can be easily tested. We are continuing to test and determine if the promised Bluetooth enhancements are worth considering compromising our approach.

- **Global Network**

ENF allows us to connect into the global ENF. While useful, the expected restrictions on international travel in the short to medium-term would render this of little use in the short to medium-term.

- **Perceived Privacy Protections**

Certain users who have avoided COVIDSafe may perceive that the ENF provides stronger privacy protections though this largely decentralised, non-government-controlled model.

Key Technical Challenges of the ENF Model

- **Significant changes to the COVIDSafe system**

Our initial investigation has revealed that adopting the ENF will require significant technical changes including:

- All current users would need to transition to the new App (download and re-register) and contact data collected to date would not be transferred.
- The App would need to be significantly redesigned and rebuilt. The ENF cannot simply be embedded into the current app.
- The Health Portal would also need to be redesigned and rebuilt.
- A new Privacy Impact Assessment would need to be conducted and legislative amendments may be needed

- **Less device compatibility**

The ENF offers less device compatibility compared to our current system for Apple users. The ENF is only compatible with iPhone 6 or later that are running iOS version 13.5 or above (released on 20 May 2020). Android users running version 6.0 or later will be able to access the ENF. This provides less community penetration compared to our current system.

Key Challenges to Australia's centralised contact tracing model of the ENF Model

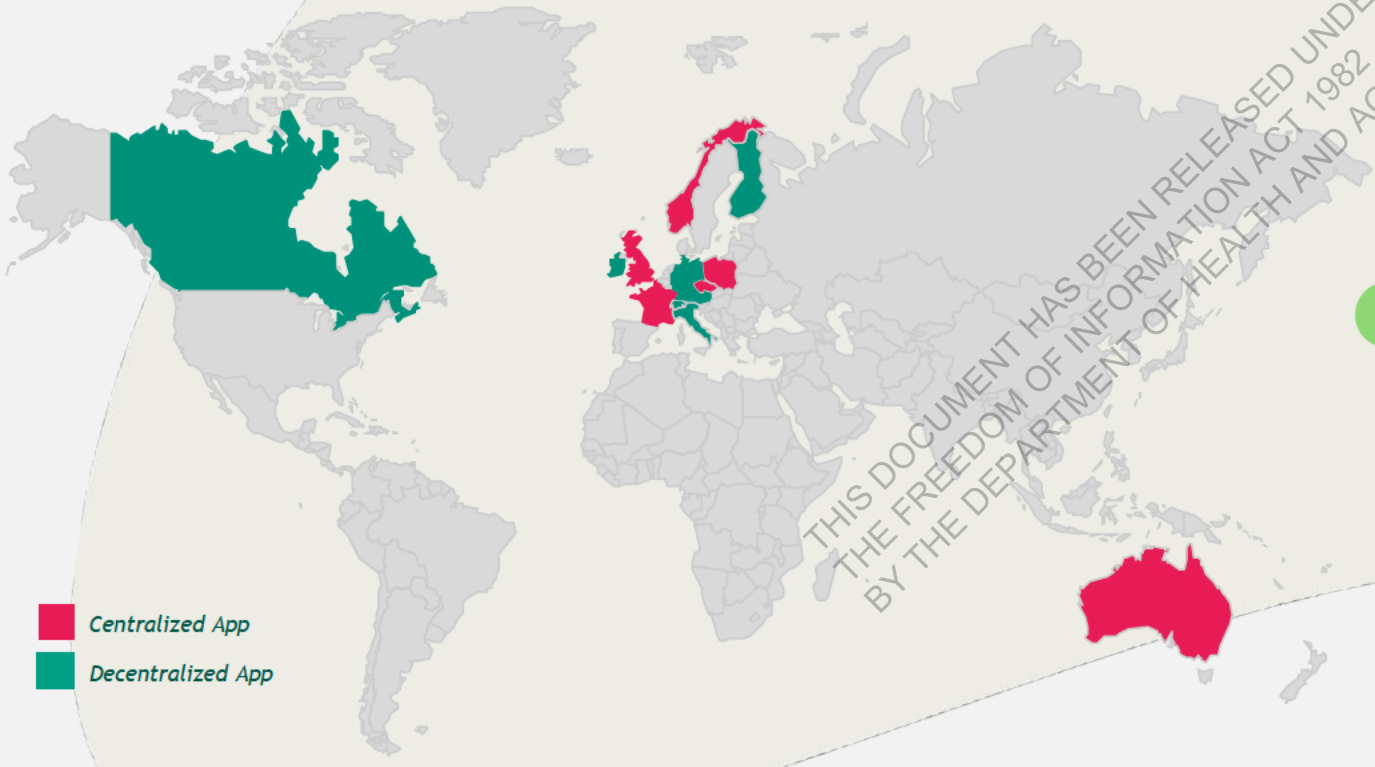
- Adopting the ENF would mean revisiting decisions that have underpinned our current model supporting public health outcomes. The decentralised model that Apple and Google are proposing would undermine our sovereignty over health policy and limit access to the information required to allow the States and Territories to effectively manage the pandemic and recovery.
- In the ENF, a close contact is never directly matched to a person who tests positive, this limits a public health official's ability to undertake heat mapping or the identification of clusters.
- Public health officials will have a lower level of visibility of close contact cases under the ENF. Users can skip providing personal details on registration and stay anonymous.
- Push notifications are the primary mechanism to notify close contacts under ENF. Notifying close contacts through an app-based notification may cause alarm, particularly if health officials are not involved. This is a significant difference to the COVIDSafe framework.

Technological Changes Required

- There are significant changes in technical functionality of the APIs, meaning current app functionality will need to be refactored/configured including removing Bluetooth functionality and the PHO portal will need reconfiguration
- GA requires a decentralized matching of Bluetooth encounter data with the positive diagnosis list on each user's device - contrary to COVIDSafe's centralized model in which this occurs on the National Data Store
- GA does not allow PHO access to close contact data including the positive diagnosis list or to know the phone number of close contacts for manual contact tracing - contrary to Australian requirements
- Apple requires version 13.5 and above, and unless forced updates are introduced this could significantly reduce the addressable population using iOS devices (however beyond the short term this concern could be mitigated as users update to new versions)

Centralised apps have been quicker to market

Adoption of centralised & decentralised contact tracing apps differ in selected geographies…



…With further distinctions in the choice of the protocol underlying the app

	App	Prot.	Live	Strat. Shift[2]
France	*StopCOVID*	ROBERT	X	X
Australia	*CovidSafe*	Bluetrace	✓	X
Singapore	*TraceTogether*	TraceTogether	✓	X
Italy	*Immuni*	PEPP-PT	X	X
Germany	*In Development*	DP3T	X	✓
Ireland	*HSE Covid-19 App*	DP3T	X	✓
Canada	*In Development*	-	X	X
Poland	*ProteGO*	WIP	X	✓
Austria	*Stopp Corona*	DP3T	✓	X
Switzerland	*Swiss Contact Tracing App*	DP3T	X	X
UK	*NHS COVID-19 App - in trial*	MIT	X	X

Note: 1. Strategy shift from Centralized approach to Decentralized approach, or vice-versa.

Privacy and functionality considerations have driven a switch to the GA-API solution in certain countries

Ireland, Germany, Italy and Denmark recently moved from building a bespoke application **to GA-API based solution**. These pivots were made in pursuit of **higher user uptake and to address potential privacy and functionality risks.** Most[1] countries are engaging with Google and Apple, and testing how to work with their APIs to enable required functionalities.

France: After public and parliamentary scrutiny on data privacy, considering parliamentary vote and regulatory assessment before launch; app may be 'temporary' measure.

Singapore: Not likely to shift from current app, as they consider Public Health requirements as the key priority. Sharing feature improvement inputs with Google and Apple for GA-APIs.

UK: Has app in pilot in Isle of Wight with ~70k (~50% of pop.) downloads, and is in discussion with GA to assess API feasibility and options.

Staying with bespoke app	Staying with GA-API compatible[2] solutions
• France • Norway • Australia • Singapore • UK • India • Israel • Iceland • Poland • Cyprus	• Netherlands • Finland • Switzerland • Estonia • Czechia • Austria • Canada • Portugal
Moving to bespoke app	**Moving to GA-API solution**
No countries in this category currently, may change after GA-API based apps are launched (e.g. if countries find the solution doesn't meet their needs).	• Ireland • Germany • Italy • Denmark

Countries in **bold** have already launched their apps

Austria: Integrating GA-APIs within current live app to resolve technical issues for iOS.

Ireland: Pivoted to GA-API approach; primarily in response to adoption concerns due to data privacy and app stability.

Germany: Pivoted to approach compatible with GA-APIs in response to pressure from media, data protection lobby and Apple.

Note : Bespoke apps refer to app making bespoke use of Bluetooth radio for contact tracing as opposed to GA-API for Exposure Notification
1.Includes Australia, New Zealand, Norway, Ireland, Denmark, Germany, Austria, France, Netherlands, Italy, Singapore, Czechia
2..Solutions include DP-3T based apps, which are aligned with the Google/Apple approach

Next Steps - testing

- We should confirm the extent of Bluetooth improvements against our connectivity benchmarks before we adopt the ENF model. A prototype is currently being built to facilitate testing.
- We should further request that Google/Apple consider changes to the model to ensure it meets Australia's Health Policy needs and centralised approach.

What would the APIs do versus the COVIDSafe app?

Functions the APIs would do, currently done by COVIDSafe app

- Present permission requests to users at the following points:
  - Before starting to scan for and broadcast beacons
  - Before providing user keys to the app for uploading to the internet-accessible server once the user has been positively diagnosed with COVID-19
  - Enables users to start and stop broadcasting and scanning
- Manage daily random keys (temp exposure key)
- Manage Bluetooth broadcast and scanning for other devices
- Identify whether the user was in close contact with a confirmed case (calculates exposure risk)

Functions the new ENF-enabled COVIDSafe app would need to do

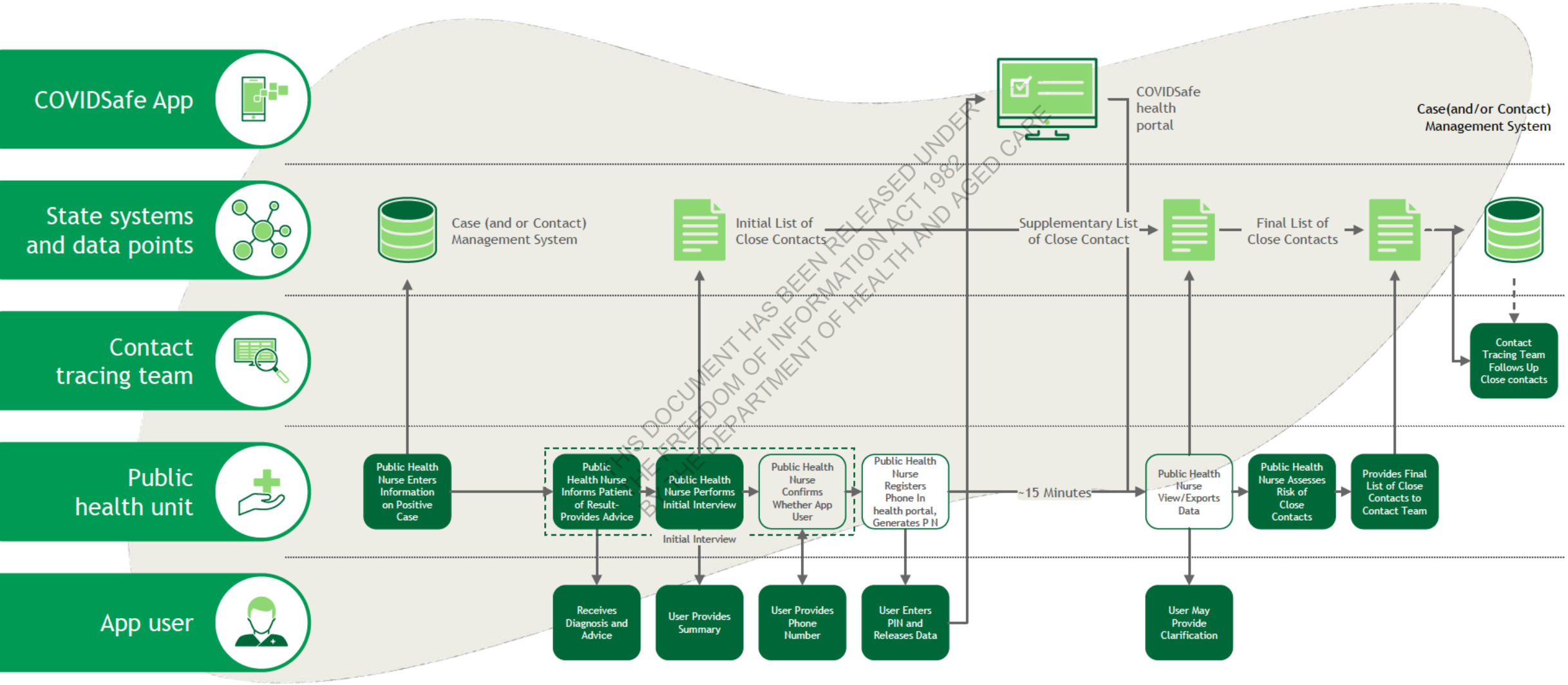
- Provide Temporary Exposure Keys, key start time number, and key transmission risk level from your internet-accessible server to the APIs
- Retrieve keys from the on-device data store and submit them to your internet-accessible server after a user has been confirmed by a medical provider as having tested positive, and the user has provided permission
- Schedule polling of your internet-accessible server for positive diagnosis keys
- Receive API calls and responds by presenting users a risk exposure notification and notification with instructions (customisable) on what to do next when the user has been exposed to another user who has tested positive for COVID-19

Source: Apple Google exposure notification architecture specification v1.3.1

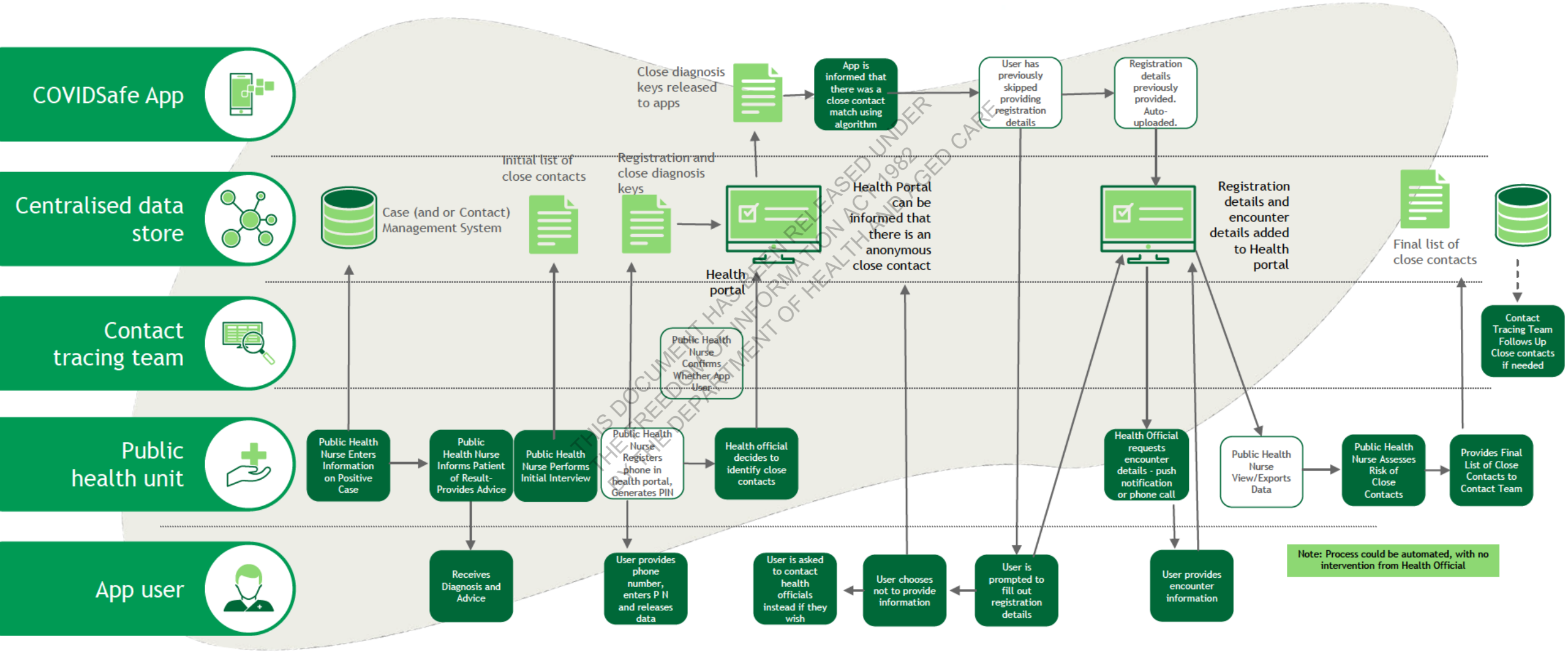
Pros and cons of alternative options

Options	1 Keep COVIDSafe, do not adopt GA APIs	2 Redevelop the app using GA APIs, using decentralized model	3 Redevelop the app using GA APIs, using centralized model	4 Keep COVIDSafe, and build new GA compliant app
Pros	+ No legislative, technical, functional changes required + PHO instigates contact tracing, diagnosis matching occurs centrally + Government retains total control over full stack design and processes + Greater immediate device compatibility + Greater control over specific security specs e.g. ACSC encryption standards + Product in market and PHOs are using, reduced effort	+ Emerging global industry standard and upgrade path to GA phase 2 + Expect more effective Bluetooth encounters logging than current workarounds + Exposure risk and close contact algorithms enhanced by international testing collaboration + Still relies on C19 positive diagnosis verification process from public health official + Able to re-use app front end and design work + App functionality can continue to be built largely to Australian specifications e.g. phone calls to close contacts (but may require workarounds) + Avoid manual steps in exposure notification + International and cross-border interoperability	+ Pros of option 2, plus + Public health official still instigates contact tracing, diagnosis matching occurs centrally and control over specifics and legislation remains	+ Users can opt in/out on based on their preference + Government has the option to decide on preferred approach later based on trial/error in real world testing (ie. retain, merge) + Provide Government with a bargaining position with GA to influence direction and GA mandated requirements (and work with allies in joint negotiation) + Unlikely to have user facing impact on migration to single app in future
Cons	- Bluetooth workaround less effective than APIs - OEM unsupported Bluetooth workaround - Will not support GA phase 2 which works/users notified regardless if they have a Govt app (i.e. risk exposure, notifications and mgmt. handled by GA) - Pressure from States/Territories to adopt GA solution or create their own - Risk of not adopting the global standard that other Govts are considering	- No public health official access to registration data or close contact data for tracing purposes (potential workarounds) - Requires legislative change to restrict access - Work required to remove Bluetooth functionality; and integrate retained App code with APIs - Requires new exposure risk algorithm and thresholds config in APIs, only pre-defined values allowed - No BLE rules customisation - Reduced iOS device compatibility, v13.5 required and released in future v14 OS update - Encryption compliance and ACSC re-certification - Need a new process to manage inbound calls - Requires migration of registrations to new app - Lose current close contact data already stored - Change management of users with new user flow - Potential impact to mobile Telco providers due to data consumption & transmittance - Privacy & security compliance still unknown	- Cons of option 1 and 2 including technical effort required and user dislike due to GA sceptics - Unlikely that Google and Apple will change approach to support centralised models, rejected many similar approaches by other governments	- Multiple apps may be confusing for users - Potential for complexity in contact tracing processes - Extra effort to build, run and maintain two apps, processes etc.

Sequential workflow - Detailed Current Model



Sequential workflow -Detailed Exposure Notification Framework



COVIDSafe and Apple/Google Exposure Notification Framework (ENF) comparative assessment

1. Executive summary and recommendations

The COVIDSafe App (the App) supports the Australian Government's public health measures to keep the community safe from the spread of COVID-19 through early notification of possible exposure. Since its launch, COVIDSafe has received widespread support and endorsement from across the Australian community with over six million registrations.

The App is a supplementary tool to support Health Officials undertaking contact tracing. It allows them to expedite the identification of close contact encounters and confirm close contact encounters identified through manual contact tracing practices.

The COVIDSafe system has now been in operation for just over two months, which has allowed us to access and analyse data on its performance. We have also analysed Apple and Google's Exposure Notification Framework (ENF).

There are two parts to the COVIDSafe system: the App, which captures Bluetooth handshake data, and the backend Health Portal. An algorithm is applied in the Health Portal to filter out captured data so that only close contacts are presented. Close contacts are defined as encounters of 15 minutes or more at a distance 1.5 metres or less.

We have identified three issues that impact COVIDSafe's performance - dormancy, performance when the App is background, and close contact filtering in the backend Health Portal:

- Dormancy - The App is dormant when it has not contacted the server in the last 7 days. About half of all COVIDSafe registrations appear to be dormant now.
- App in background - A performance limitation can occur while the device is locked and the App is in the background. This can cause half to three quarters of close contacts to be missed, depending on the operating system and how long the devices have been locked.
- Filtering - The DTA is implementing a solution to improve the performance of the filtering algorithm in the backend Health Portal. The algorithm update is based on data and user feedback received from State and Territory Health Officials. The filtering algorithm will change to capture close contacts more accurately and this change can be achieved independently of the ENF.

DTA is improving the filtering algorithm used in the backend Health Portal as part of the current release (due 3rd July). The new filtering algorithm will increase the presentation of potential close contacts, this will overcome limitations seen in the current operation of the App where phones with Bluetooth performance in the moderate (25-50%) and good (50-80%) ranges would not register as close contacts as they fail the current filtering rule. The combination of Bluetooth performance (handshake capture) and filtering means the majority of interactions are being filtered out and not shown. Under the new filtering

rule, the number of close contacts presented rises from 4 percent to approximately 50 per cent for phones locked and the App in the background state.

We have tested the ENF as an option to resolve the dormancy and background performance issues. This document sets out what we know about the comparative performance of COVIDSafe in relation to using the ENF when the App is running in the background.

Early results suggest that the ENF, from a technical perspective, would likely solve the background performance issues almost completely meaning close contact presentation would rise to 100 per cent when combined with the new filtering algorithm in a hybrid COVIDSafe / ENF model.

2. Contact tracing filtering algorithm

The DTA is improving the filtering algorithm used in the backend Health Portal as part of the current update (due 3rd July 2020). The new filtering algorithm will more accurately present potential close contacts to Health Officials to improve contact tracing processes. This will overcome limitations seen in the current Bluetooth operation of the App, which is not capturing all expected handshakes over a 15 minute period (15 handshakes over 15 minutes) when the App is running in the background. Under the current algorithm, these would not be presented as close contacts as they fail the current filtering rule. It is possible to lose a single handshake for a number of reasons, including environmental interference, which would mean by definition a close contact would not be recorded.

For example, when a close contact occurs and the App is performing in the "good range", it captures 50 to 80 per cent of expected handshakes. The current filtering algorithm would erroneously not capture this close contact due to the non-consecutive nature of the digital handshakes. When the App is performing "moderately", it is only capturing 25 to 50 per cent of handshakes and the same filtering issue occurs.

Based on these tests, the new filtering algorithm will define a close contact as a sequence of 3 or more digital handshakes over a period of 15 minutes with no more than 15 minutes between any consecutive pair.

The combination of Bluetooth performance (handshake capture) limitations and the current filtering algorithm means that relevant close contacts captured by the App are filtered out and not shown to Health Officials. By changing the filtering algorithm, without any changes to App performance, we will see the number of close contacts presented to Health Officials increase from four per cent to approximately 50 per cent when phones are locked and the App is in the background state (on iOS to Android and Android to Android pairs of phones).

Current COVIDSafe performance in a background state

There are 19.7m Australian residents aged 18 or older (July 2019; ABS estimate). We estimate 17.9 million Australians have an iOS or Android smartphone, 95 per cent (17.1million) of whom have an operating system compatible with COVIDSafe. This means around 87 per cent of Australian resident

adults can use COVIDSafe. As of 22 June 2020, there have been 6.4 million users have registered - about 32 per cent of resident adults.

To estimate the number of apps that are active, we have counted the number of unique devices which make at least one request to the server in a 7-day period.

In the 7 days to Monday 22 June, 2.8 million unique devices contacted the server, in roughly equal numbers between Apple and Android. This is 44 per cent of the number of COVIDSafe registrations.

More recent tests have varied the time for which the App had been in the background before the close contact event. In these tests the App was moved to the background (two other apps were used subsequently) and then locked with the screen off for 10 hours. The performance 2 hours and 8 hours into the test is tabulated below.

The table shows the performance results over time when combined with the improved filtering algorithm described above. The performance still falls off with time, especially for iOS.

Table 1: Share of close contacts (not Bluetooth handshakes) captured and displayed over time when the phone is locked, the App is in the background, and the new filtering algorithm is applied.

Share of close contacts detected as function of time after phones are locked and in background state	~2-4 hours	~ 8-10 hours
iOS-iOS	36per cent	0per cent
iOS-Android	47per cent	33per cent
Android - Android	59per cent	32per cent
Average (weighted by active users)	47per cent	25per cent

3. Performance of the ENF

Testing of a prototype app using the ENF shows that the ENF could potentially resolve the limited background performance issues. The initial signs are very promising.

The tests that were able to be performed indicate 100 per cent performance (digital handshake exchange) when the app is in the background. That is, all close contacts were detected. Further testing is needed to demonstrate this can be delivered reliably and after the app has been in the background for many hours.

We note that tests of the background performance were more difficult to perform than the tests for the current COVIDSafe App. The approach to preserving privacy under the ENF interferes with testing. For example, fully powering down an iOS device appears to interfere with the recording of very recent exposures.

The ENF-based app has not been available for long enough to measure dormancy. However, since the Bluetooth scanning and advertising is part of the operating system, rather than an app, it is likely that dormancy would be improved also.

Initial indications show that depending on the operating state of the phone, the ENF by itself could lead to a 2x to 4x increase in the close contacts identified compared to COVIDSafe performance. Combined with the improvements to the filtering algorithm, this figure rises further and has the potential to meet 100 percent identification of close contacts under a hybrid ENF / COVIDSafe model.

However, there are several considerations for Government around adopting the ENF including:

- The decentralised approach is problematic in the context of our sophisticated and successful centralised manual contact tracing system. It has been non-negotiable with Apple and Google.
- The current COVIDSafe implementation allows us to have more control over updating the contact tracing filtering algorithm in COVIDSafe to better capture close contacts.
- Currently Health Officials manually determine who is a close contact, using a matching process that occurs in the Health Portal. This approach has been successful in identifying close contacts within Australia. The determination of a close contact under ENF is decentralised. It is calculated through an algorithm on the local device. There is no discretion to make calls on risk on a case-by-case basis. This is not compatible with our current manual tracing process.
- Since a close contact is never directly matched to the relevant positive case, this limits public health officials' ability to identify clusters and respond to an outbreak.
- Currently Health Officials call users to inform them that they are a close contact. Under ENF, anonymous users could only be notified through a system notification.
- The ENF offers less device compatibility compared to our current system for Apple users. The ENF is only compatible with iPhone 6 or later devices running iOS version 13.5 (released on 20 May 2020) or above. Android users running version 6.0 or later will be able to access the ENF.
- Apple and Google would require users to re-register to use the ENF. "Registration fatigue" may set in (especially with low current infection rates) or people may be put off if they distrust large corporations.
- Should we switch, we would also lose access to any close contacts detected in the prior 14 days on phones running the current COVIDSafe App.

4. Potential improvements within the current COVIDSafe framework

Should the above ENF limitations be overcome, a hybrid model that combines the strengths of our current contact tracing model and the technology enhancements of the ENF is a better outcome for Australia's contact tracing processes. A hybrid approach would improve the background performance and dormancy issues. It would support contact tracers to expedite and improve the identification of close contacts.

If a decision is made not to pursue the ENF, there may be other ways to improve the performance of the current COVIDSafe app. Resolving the issue of limited performance when the app is in the background with the phone locked would give 2-4x more close contacts. This would require the identification of further technical modifications to COVIDSafe to ensure the app remains active however this may affect battery life. However further technical improvements may also be limited within the operating restrictions enforced by Apple and Google.

About 500,000 iOS devices appear to have gone dormant in the week to 22 June 2020. If the full 500,000 could be won back, it would improve the overall detection rate by about one quarter to one third. One way to reduce dormancy would be to remind users to turn on the app through targeted communications. Communications and media could also look to increase the number of downloads of the app. Doubling the number of people who have downloaded the app would give a 4x increase in the number of contacts found.

From: s 47F
To: s 47F
Cc: s 47F Anthony Warnock
Subject: Re: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]
Date: Wednesday, 1 July 2020 7:07:50 PM

Hi s 47F

I was on a flight - how novel?!

Just tried to call you back. Give me a call again when you get a chance.

Cheers

s 47F

On 1 Jul 2020, at 6:29 pm, s 47F wrote:

OFFICIAL

Hi s 47F

I just tried to return your call and to also talk to you about the below request.

We really appreciate everything BCG has done to date to support the improvements to the algorithm and the ENF testing.

As we no longer have a work order in place with BCG in relation to COVIDSafe, we will not be able to cover any costs associated with this request.

Happy to discuss any options around how this work could be conducted by BCG.

Cheers

s 47F

OFFICIAL

From: s 47F
Sent: Wednesday, 1 July 2020 6:18 PM
To: s 47F
Cc: s 47F
Subject: Re: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Thanks s 47F.

We will get right onto it.

Cheers

s 47F [redacted]

On 1 Jul 2020, at 5:11 pm, s 47F [redacted] wrote:

OFFICIAL

Hi s 47F [redacted],

Whoever you need to work with is fine by me. The changes and recommendations will go through myself as product manager for the Health Portal. I forwarded my previous correspondence to s 47F [redacted] so they were aware of the request.

Thanks
s 47F [redacted]

OFFICIAL

From: s 47F [redacted] >
Sent: Wednesday, 1 July 2020 4:52 PM
To: s 47F [redacted]
Cc: s 47F [redacted]
Subject: Re: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Hi s 47F [redacted]

Do you want us to work with s 47F [redacted] to help with this?

Cheers

s 47F [redacted]

On 1 Jul 2020, at 12:00 pm, s 47F [redacted] wrote:

OFFICIAL

Thanks gents for the responses. The approach below looks good. Let's get working on this.

OFFICIAL

From: s 47F [redacted] >
Sent: Wednesday, 1 July 2020 11:56 AM
To: s 47F [redacted]
Cc: s 47F [redacted]

Subject: RE: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Hi s 47F

That's a very impressive set of calibration data! s 47F and I have been answering at the same time – this is a longer version of his answer:

Yes, we should use these as a correction to our attenuations – it will make the distance calibration work better.

But it will need new testing. When I picked the thresholds I took a cautious approach, given that we don't have a device correction, so we needed to be confident of not eliminating all the true positives almost regardless of the device being used. With the correction the thresholds will need to be re-set, but it's not obvious where. If we had the apple corrections as well I could actually re-process my test results with the corrections and see where a good cut-off would lie and whether it does reduce the "noise" in the signal.

My tests were necessarily crude given the time pressure – it might actually be better NOT to use them, but instead to copy (for example) the German formula in use with Apple/Google ENF, since they're likely to have done a lot more testing.

Even then it's probably worth doing a little more testing (or reprocessing) – the link you sent talks about using a single Bluetooth channel for Android (channel 37). Unfortunately, in real world situations the channel influences the signal strength because the it determines the wavelength and this determines how the signal which bounces from the floor interacts with the one which travels directly – the phone sees the aggregate signal. I suspect this impact is much smaller than things like handbags and phone cases, but I'd want to either do new end to end tests or at the very least re-process my tests with the new limits to check they come out about right.

Best wishes
s 47F

—

s 47F
[redacted]

<image001.png>

From: s 47F [redacted] >
Sent: Wednesday, 1 July 2020 11:30 AM
To: s 47F [redacted]
Cc: s 47F [redacted]
Subject: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Morning s 47F ,

Firstly, I wanted to thank you for you hard work on the latest update to the 15+ minute rule implementation within the COVIDSafe Health Portal. I also wanted to let you know that following approval by the (many) relevant authorities, the new algorithm is set to be released to production this Friday. I imagine this work will provide significantly improved outcomes for contact tracers and I'm very much looking forward to seeing the results.

Secondly, I wanted to bring to your attention updated information regarding the Apple/Google Exposure Notification Framework, which is almost identical to ours. s 47F from Delv sent me the following link this morning, that discusses the Apple/Google formula with the addition of device calibration.

https://developers.google.com/android/exposure-notifications/ble-attenuation-overview

Further, Google has listed almost 10,000 Android devices with their calibration values for incorporation into the formula, as we were looking to do with data from GSMA. Google has also mentioned it's working to get calibration information for Apple devices.

I was hoping to get your take on implementing the formula from Apple/Google and if there is anything you think we should be aware of before attempting to implement?

Thanks
s 47F

s 47F
Digital Delivery and Corporate Division
Digital Transformation Agency (DTA)
Australian Government
P s 47F
E s 47F
www.dta.gov.au

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The DTA acknowledges Traditional Owners of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respect to Aboriginal and Torres Strait Islander cultures; and to Elders both past and present

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Thank you.

From: s 47F
To: Peter Alexander; Anthony Warnock; s 47F
Cc: s 47F
Subject: Apple + Google Exposure Notification APIs/OS
Date: Tuesday, 19 May 2020 11:00:48 AM
Attachments: image003.png

Hi Peter, Anthony, s 47F

We did some analysis of the Google/Apple (GApple) exposure notification APIs and future OS embedment and reviewed the DTA deck provided yesterday. Here is our quick feedback:

Feedback on DTA deck

- Very much agree with the changes and observations of the G+A APIs, noting the focus of discussion is mostly on Phase 1 not Phase 2
- We think you need more focus on some significant implications:
  - The APIs are only compatible with iOS version 13.5 and above, significantly limits the addressable market (even if Apple force migrates users up, many devices will not be compatible). You should confirm approach with Apple and the expected impact.
  - Exposure notifications will be built into OS in phase 2 in the coming months and are likely to become a global industry standard, especially to support cross-border and international movement. You probably need to commence some form or alternative app (similar to UK, Singapore) or risk being left behind/out down the track, delay learning curve etc.
- The recommendation appears binary i.e. either G+A solution or COVIDSAfe only, but there are other options such as running both in parallel
- Actions have been identified to help make a decision, but resolving all of them will take too long and we think a position will be required sooner. The G+A APIs will be released soon. External pressure and criticism will then mount on the government to say what it plans to do. You need an agreed approach and response ready to go by the time the APIs are released or very soon thereafter.

Our advice at this stage would be

- Keep running COVIDSafe and build a separate G+A compliant app in parallel
- Engage Dept of Health, States and Territories, CMOs and APHHC on implications of alternative model for contact tracing
- Prepare for decision to merge, migrate once clear on preferred approach

Would be happy to discuss the options and help inform a decision here

Cheers,
s 47F

—

s 47F
[redacted]
[redacted]
[redacted]

s 47F
Sydney, Australia

s 47F

From: s 47F
To: s 47F
Subject: RE: DRAFT summary of ENF [SEC=OFFICIAL]
Date: Thursday, 18 June 2020 5:43:12 PM
Attachments: image008.png
image009.png
image003.png
image006.png
ENF-analysis v1.1.pdf

Hi s 47F and s 47F

Here's the revised report incorporating s 47F feedback.

On the separation of performance from "what next" I think there may be a way to separate but reducing the risk of misleading - which would be to summarise all of what we know about the effectiveness of each stage of the "whole funnel":

- Has smartphone
- It's suitably modern
- Downloaded app
- Registered
- Still active (got an identifier in last 24h)
- Works when phone is locked
- Agrees to upload contacts if found positive (100%?)
- Contact tracer able to see and act on contact

We could then collate what we know about each step - improving any of the ratios from one step to the next improves the overall performance, and this cold help to prioritise improvements.

Obviously one of the steps 'works when phone is locked' is what the current tests are probing for ENF, and I think we need to revisit for the current app too. It will take a few days to put this together (I'll need to ask you for some data and we need some more test results) - but happy to do so if you think it helpful

s 47F

—

s 47F

From: s 47F >
Sent: Thursday, 18 June 2020 10:25 AM
To: s 47F
Subject: RE: DRAFT summary of ENF [SEC=OFFICIAL]

s 47F,

s 47F may have a different view but I think the problem is that the results of the relative effectiveness tests have the potential to mislead. For example, you could easily conclude that a 2-4x effectiveness improvement means we should switch, but the answer is not that simple. You need to look at it combination with the take-up and other issues to measure the true relative

effectiveness.

Cheers
s 47F

—

s 47F

From: s 47F
Sent: Thursday, 18 June 2020 10:18 AM
To: s 47F >
Subject: RE: DRAFT summary of ENF [SEC=OFFICIAL]

OFFICIAL

Thanks s 47F

I have a request with how we present the analysis.

I am hoping we can decouple a little. Analysis that shows the findings from the tests. And then a separate write up on possible next steps.

We are wanting to keep the test results and the possible next steps separate at this point so we can share the actual results with our various stakeholders, but can keep the next steps analysis up our sleeves to use in certain briefings.

Does this make sense?

Thanks

OFFICIAL

From: s 47F >
Sent: Thursday, 18 June 2020 10:09 AM
To: s 47F >
Subject: RE: DRAFT summary of ENF [SEC=OFFICIAL]

Thanks both; I'll revise now

V1.2 question: I modelled it separately initially but the difference is very small - happily not many people are pre V1.2 (about 11% of iOS users based on email snippet copied below)

Further testing:

- I suspect the ENF will hold up very well technically - it's done very well so far, the engineering logic is compelling and the German story also points in that direction. But we need to be sure.

- For *current* it's really not clear what the true performance is - different tests have given inconsistent results
- But the 'missing iOS' issue is really important and could be a reason to switch regardless of performance on devices in which the app is still active
    - Even if there's no 'asleep' benefit, switching to ENF would be beneficial at take-ups above 50%, only because of solving the 'missing iOS' problem
    - Benefits rise sharply at any greater take-up than this

s 47F

From: s 47F
Sent: *Monday, 15 June 2020 4:03 PM*
To: s 47F
Subject: *RE: Data [SEC=OFFICIAL]*

OFFICIAL

And for iOS, the app version they are on:

COVIDSafe/1.0 78369
COVIDSafe/1.1 25295
COVIDSafe/1.2 5915
COVIDSafe/1.3 38520
COVIDSafe/1.4 23447
COVIDSafe/1.5 769655

—

s 47F

From: s 47F
Sent: Thursday, 18 June 2020 9:28 AM
To: s 47F
Subject: RE: DRAFT summary of ENF [SEC=OFFICIAL]

OFFICIAL

Thanks for providing this s 47F .

s 47F comments cover most of my thoughts. I am looking forward to further updated results once we complete the testing of devices in the various states.

Cheers

s 47F

OFFICIAL

From: s 47F >
Sent: Wednesday, 17 June 2020 10:50 PM
To: s 47F
Subject: RE: DRAFT summary of ENF

Hi s 47F

Looks good.

Sounds to me like the key messages are

- ENF appears to be 2-4x more effective than current app at recording true close contacts in the 'most challenging circumstances'
- Switching to the new app is likely to be equivalent or worse, until you reach ~30% take-up of current registered users
- Running both apps in parallel is probably best in the short term, and maybe in the long term, but probably not much better once you reach 50% take-up

Some quick questions / comments

1. Does this take into account the fact that some users of COVIDSafe today have not updated the app to take advantage of the Bluetooth enhancements in v1.2 ?
2. Minor stylistic preference – but when referring to the existing app as V1 this might confuse because that sounds like the first version of the app, and we've had a few release since the initial version – maybe we could change the reference to something else, like Current v. ENF
3. P4 – first paragraph, last bullet point says 'but users with different families', .. not sure what you mean
4. Maybe change reference of true contacts to 'true close contacts' given that's what we are testing effectiveness for

Do you expect this to change much even after we do the test after the apps are asleep for 2+ hours?
I would have thought not.

Cheers
s 47F

—

s 47F

From: s 47F
Sent: Wednesday, 17 June 2020 9:36 PM
To: s 47F

s 47F

Subject: DRAFT summary of ENF

Hi s 47F - I think s 47F has spoken with you about how the 'missing iOS' issue makes a large difference to the result - it strongly strengthens the case for investigating ENF. I've now reflected this in the analysis and writeup attached. This is a first draft, and for the sake of speed, you and s 47F are the first to see it now. I'd very much appreciate all comments and improvements!

s 47F

—

s 47F

Sydney, Australia

s 47F

Thank you.

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BCG GAMMA

BCG Digital Ventures

COVIDSafe Apple Google ENF options evaluation

Rev.	Date	Author / Editor	Comments
1.0	2020-06-17	s 47F (BCG Gamma)	Initial draft
1.1	2020-06-18	s 47F (BCG Gamma)	Minor clarifications

Scope

This summary compares the performance of the Google Apple Privacy Preserving Contact Tracing Exposure Notification Framework (ENF) with the current implementation of the COVIDSafe app (referred to as '*Current*' in this document). The ENF offers several potential advantages over *Current* and this document does not cover all of them, but focuses on Whether the ENF would find materially more "true positive" contacts, because of improved background / locked / dormant performance.

Real-world, locked / background testing with both the ENF and *Current* is ongoing and there remains significant uncertainty as to their relative performance - therefore a range of reasonable estimates has been used. The main conclusion - to investigate a 'use both' approach is robust to these assumptions - but a 'switch' approach (which is simpler) may be a more viable alternative for practical reasons if the ENF performance benefit is on the higher end of the range considered.

The ENF has some drawbacks in the Australian context of highly-successful manual contact tracing. These will need to be weighed against the more technical performance benefits discussed here.

Executive summary and recommendations

Recommendation 1: Continue to explore the ENF approach - there is a strong prima-facie case for it

If about half of *Current* users of COVIDSafe were to switch to an ENF based app, we would expect 2x to 4x more 'true close contacts' to be identified through the system, although there may be other ways to achieve some of these benefits.

Initial testing suggests that between pairs of 'active users' but with devices which are 'asleep', the ENF identifies 2x to 4x more true close contacts than the *Current* app. This is still being confirmed, and the true answer may lie outside this range.

Additionally, a large fraction (89%) of iOS users of *Current* appear to have the app dormant. It is likely (and assumed in this analysis) that the ENF would solve this 'missing iOS' issue. ENF may not be the only way to resolve it however.

Recommendation 2: Follow a 'use both' rather than 'switch' approach initially

Switching to ENF will initially reduce the number of true close contacts which are identified. Running both apps in parallel (on a single device) mitigates this significantly, even if many people (eg, 40%) actually retire their *Current* app. Once the take-up exceeds about 50% increases in take-up become much more important

than retaining the *Current* app users and if retiring the *Current* app increased usage at that point (eg, by simpler messaging) it would be worthwhile.

Recommendation 3: Further testing is needed to confirm the critical assumptions

The ENF appears to find materially more encounters than *Current* in important real-world situations. The size of the advanatage is unlcear and it makes a large difference the benefits likely to be obtained, and to the rate of uptake needed to make the switch worthwhile.

Therefore we should

- Further verify the ability of the two systems to detect contacts when devices are asleep, to quantify the relative performance advanatage; this is under way through further testing and should be enhanced through conversations with contact tracers once the new implementation of the 15 minute rule is implemented (until then the performance of the *Current* system will be severely degraded compared with the performance assumed here)
- Confirm that ENF solves the dormant iOS app issue (through longer term testing) and that there is not another explanation for the apparently missing iOS users
- Start to investigate likely reaction to asking people to run two applications (eg, focus groups) and uncover likely misconceptions / objections

---

Relative performance of ENF and *Current*

The COVIDSafe app enhances manual contact tracing where people are in contact with strangers, for example:

- on public transport
- at sporting, cultural, or mass political events
- in restaurants which do not take bookings

In these circumstances it is likely that

- Many other people (and hence devices) will be present at the same time
- Devices will commonly not be in use - ie, screens will be off and devices locked, and may have been for some time
- The COVIDSafe app will almost never be the app most recently used by the user

Therefore this is based on tests in which multiple devices were present and the phones were locked (and had been for some time) and other apps used in the meantime.

Current tests

Testing of 11 devices using *Current* in order to develop a more suitable implementation of the 15 minute close contact test indicated that with that more suitable implementation, *Current* would identify a 'true' close contact about 50% of the time, when devices were locked.

More recent testing (15 June 2020), in which 8 devices were given 2 hours in the locked screen-sleep state before exposure, suggested a lower performance. The results are still being analysed but a preliminary estimate is that no more than about 25% of true close contacts were detected.

Versions 1.2 and above of the *Current* iOS app delivered improved detection performance for locked devices compared with prior versions. Only about 10% of iOS users are using versions below 1.2, and so their reduced performance has not been taken into account in this modelling. Taking account of it would slightly strengthen the case for implementing ENF.

ENF tests

ENF testing is more difficult because of having very little access to the data which leads to an exposure notification, and testing is still under way but early results are promising. 5 recently-locked iOS devices all

saw eachother when they should have. Testing is being extended to Android devices, and devices which have been locked for at least two hours before exposure.

Relative performance

Based on these preliminary results, we have modelled relative performance ranging from 2x (50% for *Current* and 100% for ENF) to 4x (25% for *Current* and 100% for ENF).

Switch to ENF approach

OS version issues

The ENF requires iOS version 13.5 or above. About 25% of users of iOS 10 and above (needed for *Current*) are not yet on any version of iOS 13 which was launched almost 12 months ago. It's likely they would be unwilling or unable to upgrade to iOS 13.5.

For Android the situation is better - 97% of users of Android 5 and above (needed for *Current*) are using Android 6 or above (needed for ENF).

Currently about equal numbers of Android and iOS users have downloaded the app, which gives a blended estimate for the upper limit on the number of current users who could use ENF is 86%.

The missing iOS users

Currently, only about 10% of active users (those who contact the server to register a new identifier each day) are using iOS. So for every 100 active users there are:

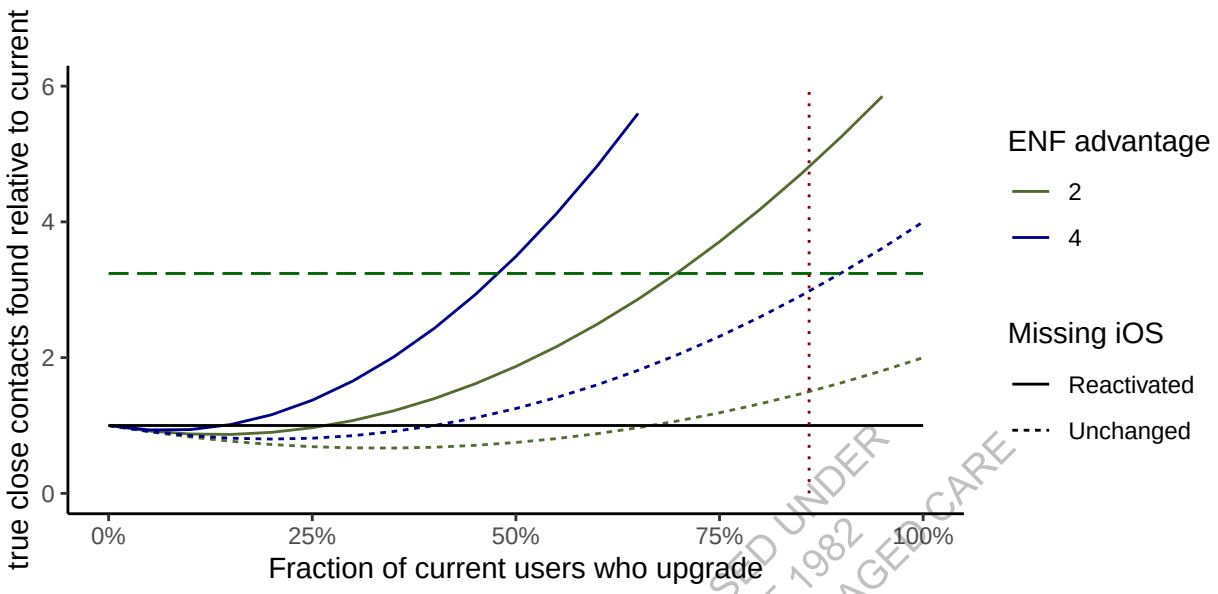
- 90 Android users
- 10 iOS users
- But since there were roughly equal numbers of downloads, there are also probably 80 "missing" iOS users whose app has gone to sleep

Getting these missing users back would be hugely valuable. The number of true close contacts found increases with the square of the number of active users, so reactivating these iOS users would increase the number of close contacts found by a factor of 3.2.

It's unlikely the ENF would suffer from this, and in the analysis here it is assumed that we could reactivate a proportion of these 'missing' iOS users in proportion to the fraction of active users who chose to install the ENF app. This assumption generates a large fraction of the benefits ascribed to using ENF. If we could find another way to do this the ENF approach provides a smaller incremental benefit, especially for a 'switch' rather than 'use both' approach.

Model

It would be possible to switch to the ENF model for example by releasing a V2 upgrade which used this framework. The benefits are highly dependent on uptake, and this is uncertain since users would almost certainly need to re-register.



The chart above shows the overall ability of the system to find true close contacts, compared with now, allowing for

- how many users would have each type of app
- the fact that ENF performs better (shown for 2x and 4x in different colours)
- the "missing iOS" users who would be reactivated by the ENF approach
- but ENF users would never log encounters with *Current* users and vice versa

The solid black horizontal line shows the current performance; the dashed green horizontal line shows the relative performance which would be achieved from solving the 'missing iOS' issue alone (eg, without using the ENF framework); and the vertical red line indicates the likely upper limit on take-up because of iOS version issues.

From this it can be seen:

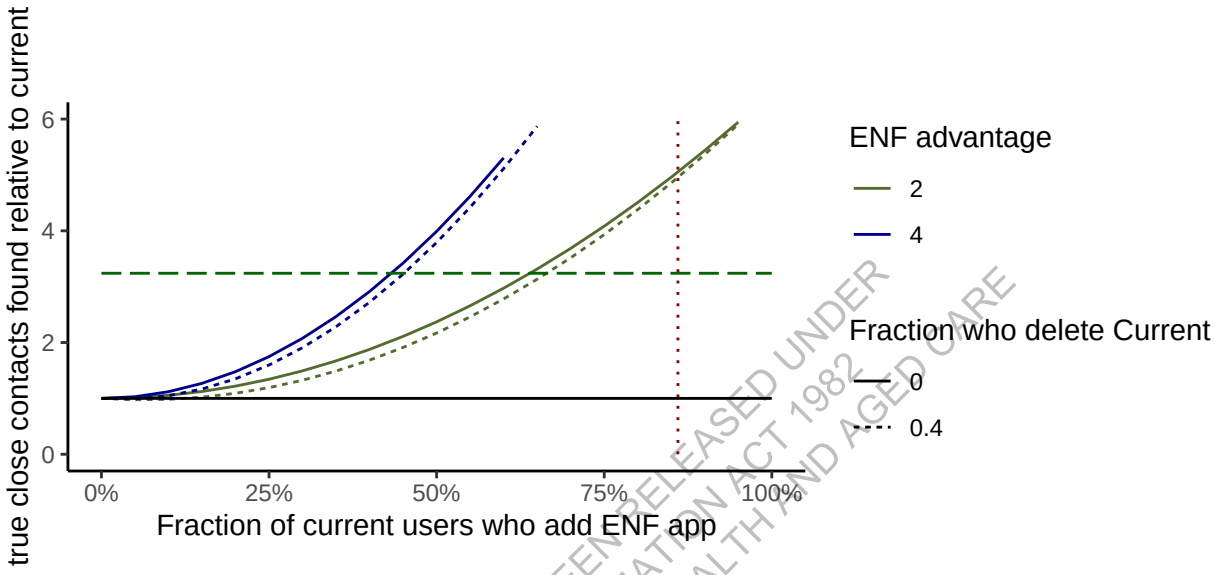
- a large improvement in performance could follow from switching to the ENF
- this is in large part because of solving the 'missing iOS' issue - benefits are smaller and require much larger take-up if ENF does not solve this, or if it could be solved in another way
- under all scenarios there will be a degradation of performance while / if the uptake is low; this is because users of the ENF cannot 'see' users of *Current* and vice-versa.
- As long as the ENF solves the 'missing iOS' issue, performance overall will improve when the uptake exceeds ~30% of users

Use both

An alternative approach would be to use both approaches in parallel. This cannot currently be done in a single app on Android (because of the permissions required) and it seems highly unlikely Apple would approve a single app using both systems. However, it should be possible for users to run two apps - one using

each framework.

However, some users who install the ENF app may stop using or remove the *Current* app. If so, there is some risk of reduced performance. The chart below shows what happens if 40% of the ENF users stop using *Current*, as well as a base case in which this does not happen.

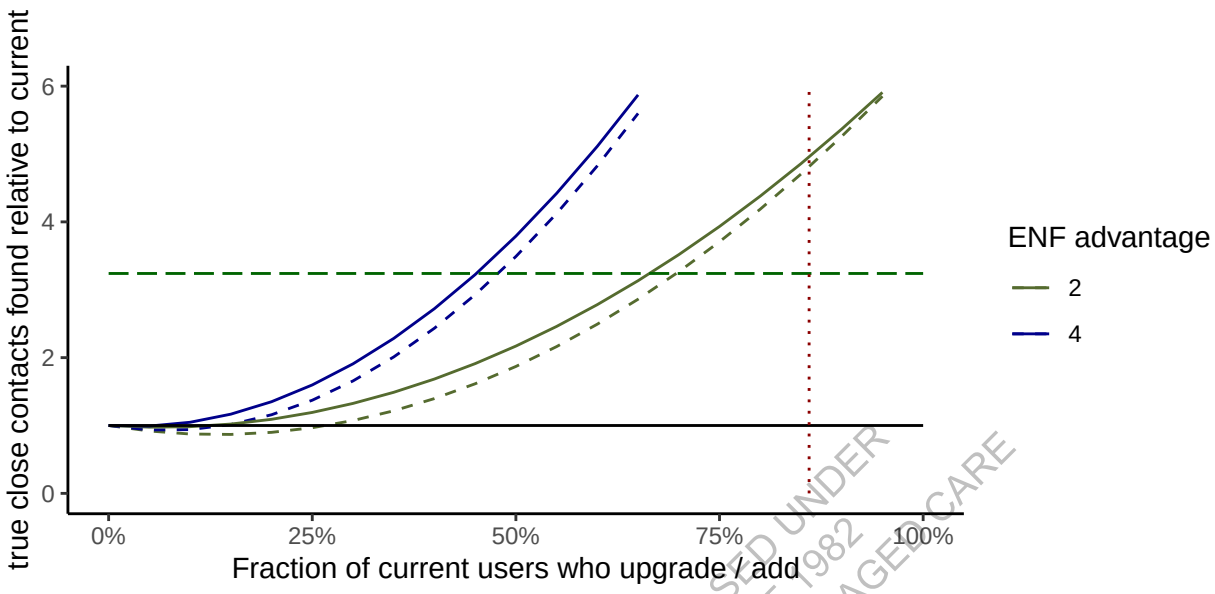


From this it can be seen that

- There is very little downside in performance for small take-up rates, even if a large fraction of users (40%) retire the old app when installing the new one, it will not have a material impact on benefits or decisions
- There are material benefits even at low take-up rates of ~25% (This is driven in large part by resolving the 'missing iOS' issue - which is assumed in this plot)

Comparison of the two approaches

The chart below compares 'switch' with 'use both', assuming that 40% of users retire their *Current* app in the 'use both' situation (pessimistic assumption).



The solid lines show the 'use both' approach and the dashed lines the 'switch' approach. This shows that

- Regardless of approach, a 50% take-up of ENF will significantly improve the ability of the system to find true close contacts (2x to 4x more)
- the 'use both' approach performs better at all levels of take-up - as expected - but once the take-up exceeds about 50% becomes unimportant compared with any small increase in take-up which can be obtained. If retiring the *Current* app increased usage at that point (eg, by simpler messaging) it would be worthwhile.

From: s 47F
To: s 47F
Cc: s 47F Anthony Warnock
Subject: RE: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]
Date: Friday, 3 July 2020 1:20:47 PM
Attachments: image002.png

Hi s 47F

Yes, I'll have a chat to s 47F about it today and come back to you. I will assume as we discussed, that s 47F would help with the requirements, but the development and testing work would be done by others, and s 47F would then do the analysis of the test results and calibration work. Let me know if you had something different in mind.

Cheers
s 47F

—

s 47F

From: s 47F
Sent: Friday, 3 July 2020 9:44 AM
To: s 47F
Cc: s 47F; Anthony Warnock <Anthony.Warnock@dta.gov.au>
Subject: RE: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

OFFICIAL

HI s 47F

Would we be able to receive a quote for the additional work on the COVIDSafe Algorithm as outlined below and as discussed with myself and s 47F

Cheers

s 47F

OFFICIAL

From: s 47F >
Sent: Wednesday, 1 July 2020 7:07 PM
To: s 47F
Cc: s 47F Anthony Warnock

<Anthony.Warnock@dta.gov.au>
Subject: Re: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Hi s 47F

I was on a flight - how novel?!

Just tried to call you back. Give me a call again when you get a chance.

Cheers

s 47F

On 1 Jul 2020, at 6:29 pm, s 47F wrote:

OFFICIAL

Hi s 47F

I just tried to return your call and to also talk to you about the below request.

We really appreciate everything BCG has done to date to support the improvements to the algorithm and the ENF testing.

As we no longer have a work order in place with BCG in relation to COVIDSafe, we will not be able to cover any costs associated with this request.

Happy to discuss any options around how this work could be conducted by BCG.

Cheers

s 47F

OFFICIAL

From: s 47F
Sent: Wednesday, 1 July 2020 6:18 PM
To: s 47F
Cc: s 47F
Subject: Re: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Thanks s 47F

We will get right onto it.

Cheers

s 47F

On 1 Jul 2020, at 5:11 pm, s 47F wrote:

OFFICIAL

Hi s 47F,

Whoever you need to work with is fine by me. The changes and recommendations will go through myself as product manager for the Health Portal. I forwarded my previous correspondence to s 47F so they were aware of the request.

Thanks
s 47F

OFFICIAL

From: s 47F >
Sent: Wednesday, 1 July 2020 4:52 PM
To: s 47F >
Cc: s 47F >
Subject: Re: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Hi s 47F

Do you want us to work with s 47F to help with this?

Cheers

s 47F

On 1 Jul 2020, at 12:00 pm, s 47F > wrote:

OFFICIAL

Thanks gents for the responses. The approach below looks good. Let's get working on this.

OFFICIAL

From: s 47F >
Sent: Wednesday, 1 July 2020 11:56 AM
To: s 47F >
Cc: s 47F

Subject: RE: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Hi s 47F

That's a very impressive set of calibration data! s 47F and I have been answering at the same time – this is a longer version of his answer:

Yes, we should use these as a correction to our attenuations – it will make the distance calibration work better.

But it will need new testing. When I picked the thresholds I took a cautious approach, given that we don't have a device correction, so we needed to be confident of not eliminating all the true positives almost regardless of the device being used. With the correction the thresholds will need to be re-set, but it's not obvious where. If we had the apple corrections as well I could actually re-process my test results with the corrections and see where a good cut-off would lie and whether it does reduce the "noise" in the signal.

My tests were necessarily crude given the time pressure – it might actually be better NOT to use them, but instead to copy (for example) the German formula in use with Apple/Google ENF, since they're likely to have done a lot more testing.

Even then it's probably worth doing a little more testing (or reprocessing) – the link you sent talks about using a single Bluetooth channel for Android (channel 37). Unfortunately, in real world situations the channel influences the signal strength because the it determines the wavelength and this determines how the signal which bounces from the floor interacts with the one which travels directly – the phone sees the aggregate signal. I suspect this impact is much smaller than things like handbags and phone cases, but I'd want to either do new end to end tests or at the very least re-process my tests with the new limits to check they come out about right.

Best wishes
s 47F

—

s 47F
[redacted]
[redacted]
[redacted]

<image001.png>

From: s 47F [redacted]
Sent: Wednesday, 1 July 2020 11:30 AM
To: s 47F [redacted] >
Cc: s 47F [redacted] >
Subject: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Morning s 47F ,

Firstly, I wanted to thank you for you hard work on the latest update to the 15+ minute rule implementation within the COVIDSafe Health Portal. I also wanted to let you know that following approval by the (many) relevant authorities, the new algorithm is set to be released to production this Friday. I imagine this work will provide significantly improved outcomes for contact tracers and I'm very much looking forward to seeing the results.

Secondly, I wanted to bring to your attention updated information regarding the Apple/Google Exposure Notification Framework, which is almost identical to ours. s 47F from Delv sent me the following link this morning, that discusses the Apple/Google formula with the addition of device calibration.

https://developers.google.com/android/exposure-notifications/ble-attenuation-overview

Further, Google has listed almost 10,000 Android devices with their calibration values for incorporation into the formula, as we were looking to do with data from GSMA. Google has also mentioned it's working to get calibration information for Apple devices.

I was hoping to get your take on implementing the formula from Apple/Google and if there is anything you think we should be aware of before attempting to implement?

Thanks
s 47F

s 47F
Digital Delivery and Corporate Division
Digital Transformation Agency (DTA)
Australian Government
P s 47F
E s 47F
www.dta.gov.au

<image002.png>
<image003.png>

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The DTA acknowledges Traditional Owners of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respect to Aboriginal and Torres Strait Islander cultures; and to Elders both past and present

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message from your computer system.

From: s 47F
To: s 47F
Cc: s 47F
Subject: RE: ENF Test Results [SEC=OFFICIAL]
Date: Tuesday, 30 June 2020 12:10:20 PM
Attachments: image002.png
COVIDSafe system efficacy estimate v1.2.docx

... and with that, here it is

Best wishes
s 47F

—

s 47F

From: s 47F >
Sent: Tuesday, 30 June 2020 12:04 PM
To: s 47F >
Cc: s 47F
Subject: Re: ENF Test Results [SEC=OFFICIAL]

Hi s 47F

We can provide a word doc version.

Our standard policy is that the content of our deliverables can be reused as required, provided that it is
- not modified from its original form
- referenced with the appropriate citation

Cheers

s 47F

On 30 Jun 2020, at 10:54 am, s 47F > wrote:

OFFICIAL

Hi s 47F

Is it possible to get a copy of this report in word format? We may need to cut and paste from this document or modify it slightly depending on the audience.

Cheers

s 47F

OFFICIAL

From: s 47F
Sent: Monday, 29 June 2020 7:07 PM
To: s 47F
Cc: s 47F
Subject: RE: ENF Test Results [SEC=OFFICIAL]

Hello s 47F – here's the report we've been discussing / working on. Thank you for the thoughtful inputs. Feel free to call tonight with any questions

Best wishes
s 47F

—

s 47F

<image001.png>

From: s 47F
Sent: Monday, 29 June 2020 2:20 PM
To: s 47F >
Cc: s 47F
Subject: ENF Test Results [SEC=OFFICIAL]

OFFICIAL

Hi s 47F

Thank you for all your work on this.

I was hoping to get a sense of whether we might be in a position to finalise the report today. Do you think that might be possible?

Cheers

s 47F

OFFICIAL

From: s 47F

Sent: Thursday, 25 June 2020 6:42 PM

To: s 47F

Cc: s 47F

Subject: System efficacy

Hi s 47F – as we discussed on the phone, here's a draft of the system efficacy calculations. As I said on the phone, there's a good chance of something in here being materially wrong, so I'm currently aiming to get as much thoughtful criticism of it as I can to make sure it's robust - and I'll work with s 47F to do that. Your thoughts (and especially challenges) would be very helpful

s 47F

—

s 47F

Sydney, Australia

s 47F

Assistant to:

s 47F Gamma Lead Data Scientist

[Given name not found] [Surname not found]

ANZ FridayPuzzle

<image001.png>

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Thank you.

COVIDSafe total system efficacy estimate

Draft report
29 June 2020

BOSTON CONSULTING GROUP

Version	Date	Author	Comments
1.0	2020-06-23	s 47F [redacted]	Initial draft for discussion
1.1	2020-06-25	s 47F [redacted]	Updated server contact data
1.2	2020-06-29	s 47F [redacted]	Clarifications

1. Executive summary and recommendations

The current implementation of COVIDSafe is unlikely to be detecting more than one in ten true close contacts in the community, and potentially no more than one in one to two hundred. Increased take-up would help, but achieving detection rates significantly above one in ten true close contacts is only possible by resolving two problems:

- Apps are going dormant - evidenced by their failing to contact the server for a new temporary identifier at any time in the last 7 days. About half of all registrations appear to be dormant now
- Additionally, limited performance while the device is locked and the screen is off - common in situations in which people are in close contact with strangers. This is causing a further half to three quarters of true close contacts to be missed, depending on the operating system/s and how long the devices have been locked

There may be other ways to solve the first of these problems (dormancy), but early testing suggests the Apple Google Privacy Preserving Exposure Notification Framework (ENF) could probably solve the dormancy and screen-off performance issues almost completely.

Moving to this system is not straightforward, nor fast, nor without risk, so it is worth measuring the extent to which the dormancy problem can be solved without the ENF. This could be done in the next few weeks with a deliberate effort to remind people to 'wake' their current COVIDSafe apps.

Additionally, in order to quantify the value of moving to the ENF it will be important to understand the extent to which COVIDSafe users self-select and so tend to be particularly at risk of infection; i.e., are people who have a lot of close contacts more likely than average to download the app? If they are, and if the dormancy problem can be mitigated in other ways, the 'technical' benefits of moving to the ENF are less pronounced. The extent of self-selection should be investigated; this can be done using counts of uploads of contact data to the Health Portal backed up by discussions with contact tracers.

At the same time, it would make sense to continue to develop and test the ENF, so that any decision to adopt it could be enacted faster.

2. Introduction and context

COVIDSafe enhances Australia's sophisticated and successful manual contact tracing system by identifying close contact between strangers who would not be traced otherwise. For example, at restaurants which do not take bookings, on public transport or at political or sporting gatherings.

To make a difference, the largest possible share of true close contacts should be identified. This document sets out what we know about the current COVIDSafe whole-system performance as well as how this might be different using the Apple Google Privacy Preserving Exposure Notification Framework (ENF).

3. The contact identification funnel

For a true close contact to be identified, both people involved must:

- Have a smartphone sufficiently modern to run the COVIDSafe app
- Have downloaded and registered the app
- Have the app active (although it does not need to be in the foreground on their devices, it must not have stopped)
- Be carrying their smartphones (we can assume this will be the norm)

Additionally, since devices will often or usually be locked with the screen off in situations of close contact with strangers, it is also essential that the devices detect each other in this state; the calculations in this report assume this will always be the case for true close contacts with strangers.

3.1. Current performance

There are 19.7m Australian residents aged 18 or older[1] (July 2019; ABS estimate). We estimate 17.9m Australians have an iOS or Android smartphone, 95% (17.1m) of which have an operating system sufficiently recent to run COVIDSafe. This means around 87% of Australian resident adults can run COVIDSafe.

Since both parties in a true close contact must be running the app for it to be detected, the fraction of close contacts depends on the square of the fraction of people using the app. This means that if the 87% of adults who could run COVIDSafe were to do so, and all the elements downstream worked flawlessly, it could be expected to identify 75% of true close contacts in the community.

[1] People of any age can download and use the COVIDSafe app. Children need parental consent. The cut-off of 18 was chosen for this analysis because infection of, and (especially) transmission by, children appears to be fairly uncommon. Therefore, under 18s are not driving the number of clinically important true close contacts. However, some of the users will be under 18 and this may lead to a small over-estimate of the efficacy of the system.

As at 22 June there have been 7.1m total downloads (although some users have since uninstalled) of which 90% have registered (6.4m people) - about 32% of resident adults. If all the downstream elements worked flawlessly this means about 10% of true close contacts in the community would be detected.

In fact, this may be pessimistic because of self-selection of app users. Specifically, some people may not have downloaded the app because they have almost no contact with strangers, others may have downloaded it precisely because they do have a lot of such contacts. In other words – are the people most likely to contract COVID-19 also the most likely to use the COVIDSafe app?

If so, this self-selection effect may be large, and the upper limit on detection of true close contacts would be much larger than 10%. The size of the self-selection effect could be quantified from the fraction of recent local-transmission cases (ie, people infected in the community) had the app, and comparing it to the fraction of adults on average who have downloaded it. This can (and should) be done using a combination of counts of contact-data uploads to the Health Portal, community-transmission case counts, and discussions with contact tracers.

To prevent 'replay' attacks on the system, the app changes the identifier it reveals. In the first implementation of this, it would need a centrally-obtained temporary ID no more than two hours old. If it did not have one, an older temporary ID could be used, but these handshakes would be filtered out before being seen by public health officials, since they could be as a result of a replay attack.

Later versions change their identifier every time they reveal it, but the requirement of a centrally-obtained temporary ID has been retained. Temporary IDs are centrally managed, so we can count the requests to check that apps are still active. The app behaves differently between iOS and Android:

- In Android, an active app contacts the server every two hours. The number of requests stays stable through the day (falling off by about 10% overnight).
- In iOS, the app uses a 'lazy' approach to contact the server – and only requests a temporary ID when it needs a fresh one to reveal to another device. This means there are many fewer iOS requests and they show a very strong time-of-day pattern, with a peak rate, around midday, around 9x higher than the quietest time (2am to 4am). This makes it difficult to know how many iOS apps are active because if it does not make contact it may simply be because it is not seeing any other devices.

To estimate the number of apps which are active, we have counted the number of unique devices which make at least one request in a 7-day period. In theory this could omit some iOS devices – but a full week seems a long time to go without a single handshake with any other device if the app is active.

In the 7 days to Monday 22 June, 2.8m unique devices requested a new temporary ID, in roughly equal numbers between Apple and Android. This is 44% of the number of registrations, and corresponds to about 14% of adults resident in Australia.

Finally, the app must be effective when the devices involved are locked with the screen off. It is difficult to simulate real-world conditions because we do not know which other apps people are using, frequency of use, battery depletion and similar factors, but our indicative estimates based on testing with locked phones suggested that with the 15 minute rule implemented in its initial form (15 consecutive minutes in

which there is a handshake), only about 4% of true close contacts will be found between pairs of phones on which the app is active but locked (measured on iOS-Android and Android-Android). This rose to ~50% under a new implementation of the 15-minute rule (sequence of 3 or more handshakes lasting more than 15 minutes with no more than 15 minutes between any consecutive pair). This new implementation is currently been coded (29 June) in the Health Portal; no change to the app is needed.

More recent tests have also measured iOS-iOS performance, and varied the time for which the app had been in the background before the close contact event. This test used 4 iOS and 4 Android devices, for which the app was moved to the background (two other apps were used subsequently) and then locked with the screen off for 10 hours. The performance 2 hours and 8 hours into the test is tabulated below, using the new implementation of the 15-minute rule. The performance falls off with time, especially for iOS.

Share of true close contacts detected as function of time after phones locked	~2-4 hours	~ 8-10 hours
iOS-iOS	36%	0%
iOS-Android	47%	33%
Android - Android	59%	32%
Average (weighted by active users)	47%	25%

There may be some overlap between the dormancy (no temporary ID request for 7 days) problem and reduced background performance (table above). If so, the analysis presented here will under-estimate the system performance – by 'double counting' problems. However, permanent dormancy after 2-4 hours seems unlikely, and so the 2-4 hour performance has been used for a best-case estimate of system performance, and the 8-10 hour performance for a worst-case estimate, in both cases with dormancy taken as an additional and independent detriment to performance.

Overall this "funnel" means that the current COVIDSafe system is detecting one of every 100 (best-case) to 200 (worst-case) true close contacts in the community if there is no self-selection effect. If the self-selection effect is strong it will be doing better. The extreme would be that *only people who have downloaded the app ever have a true close contact with a stranger.* However, even in this unrealistic case, the current system will be detecting one in 10 (best-case) to 20 (worst-case) true close contacts.

4. Potential improvements within the current framework

Regardless of the size of the self-selection effect:

- If the dormancy problem could be fully solved it would lead to 5x more true close contacts being found – as more phones would 'see' eachother and record the event when contacts happen. One way to reduce dormancy would be reminders, eg
    - to reinstate automatic reminders; or
    - introduce opt-in reminders in the app; or
    - plant reminders elsewhere (eg, in the press, at sporting venues, on public transport, in restaurants, in mobile network names displayed by mobile phones) prompting users to click on the app

- About 500k net iOS devices appear to have gone dormant in the week to 22 June; this is a large jump from prior weeks which had been stable. It may reflect upgrades to iOS 13.5.1 leading to the COVIDSafe app halting – and it would be possible to address this with advertising. If the full 500k could be won back, it would improve the overall detection rate by about one quarter to one third.
- If dormancy is being caused by device reboots, advertising and other reminders could be very effective. This can be achieved in the short term and should be tested as soon as possible.
- Resolving the issue of devices with the app not dormant but with limited performance when it is in the background with the phone locked would give 2-4x more true close contacts. This would require modifications to the existing code. Some such modifications have already improved background performance, but it is not clear that there are further improvements to be had like this.
- These fixes would reinforce each other; solving both problems would find 10-20x more close contacts, resulting in between 10% and 100% of true close contacts being identified, depending on the size of the self-selection effect
- These are much larger impacts than, for example, a major take-up campaign. For example, doubling the number of people who have downloaded the app would give a 4x increase in the number of contacts found (assuming no self-selection effect; less improvement if the effect is strong).

4.2. Use of the ENF

The Apple Google Privacy Preserving Exposure Notification Framework (ENF) could potentially resolve the dormancy and limited background performance issues. A development version using the ENF has started to undergo testing:

- The ENF-based app has not been available for long enough to measure dormancy, but because the Bluetooth scanning and advertising is part of the operating system, rather than an app, it seems likely that dormancy would either not be a problem, or could be fixed with an OS upgrade
- Some tests of the background performance have been conducted. These are much more difficult to perform than the tests for the current COVIDSafe app, because the approach to preserving privacy interferes with testing in subtle and unexpected ways. For example, fully powering down an iOS device appears to interfere with the recording of very recent exposures (an issue which has been raised with Apple). However, in the last few days Apple have provided an ability to probe the ENF performance on iOS devices running a development version of the ENF-based app. The diagnostic files produced indicate 100% background performance for all iOS and Android combinations. Further testing is needed (and underway) to demonstrate this can be delivered reliably and after the app has been in the background for many hours – but the initial signs are very promising.

As mentioned above, other things equal, this would lead to a 10-20x increase in the fraction of true close contacts identified, with an absolute detection rate of 10% to 100% depending on the size of the self-selection effect. However, the ENF is not a slot-in replacement:

- Apple and Google would almost certainly require users to re-register to use the framework

  - The different approach to privacy might attract some new users (as it has in Germany), but it might also put people off if they distrust Apple or Google because they are for-profit, or because they are subject to US jurisdiction and court orders.
  - "Registration fatigue" may set in (especially with low current infection rates) and users may not feel that re-registering will make a difference, or may not realise it is needed because they have already done so
- The decentralised requirement has been non-negotiable with Google and Apple so far. This is problematic in the context of our sophisticated and successful centralised manual contact tracing system:
  - Only phones will be allowed to inform people they may have had a close contact with a case. These contacts may ignore or discount the warning, especially if false positive contact warnings are common.
    - False positives because the 'case' was not in fact infected (eg, somebody wanted to scare people maliciously) are **not** a problem in the ENF system – it is possible to ensure a health official approves all 'cases' notified to the system.
    - But false positive close contacts of true cases will be a concern because we will lose the filter of the manual contact tracing interview, and because of the limited inaccuracy of distance estimation with Bluetooth (especially in the ENF system). For example, people on neighbouring balconies of an apartment building, one of whom becomes infected, might be incorrectly identified as a close contact by the ENF but would have been eliminated in a manual contact tracing interview. ***Detecting more contacts will not reduce infection rates if those contacts do not self-isolate*** and the ENF offers health officials no way to find out whether contacts have isolated or not, nor who they are.
  - Additionally, contacts may be alarmed (contact tracers report this is a common reaction) and the app will not be able to provide the reassurance of a friendly and informed voice on the phone – although it could prompt people to call for help
  - The app will not be able to distinguish between people who have already been (or will be) identified through manual contact tracing and the manual contact tracing process will need to be adapted to allow for the confusion which could arise as a result. Manually-identified contacts may have already been told of their contact by their device, and may have already called for advice as a result, or it the ENF warning may come after the manual contact call. These situations may well confuse people if they do not understand in which ways the ENF is independent of the public health system (identity of contacts) and in which ways it is part of it (identity of cases).
- When any switch happened, we would lose access to any close contacts detected in the prior 14 days on phones running the current COVIDSafe app; this data could not be transferred to the ENF app
- Data usage may be significant; in Germany (which has about 4x Australia's population) the excess usage is estimated at 100-500 MB / month / user and the Federal Government has ensured that this data is not charged for users

From: s 47F
To: s 47F
Subject: RE: DRAFT summary of ENF
Date: Wednesday, 17 June 2020 10:50:10 PM
Attachments: image004.png
image001.png

Hi s 47F

Looks good.

Sounds to me like the key messages are

- ENF appears to be 2-4x more effective than current app at recording true close contacts in the 'most challenging circumstances'
- Switching to the new app is likely to be equivalent or worse, until you reach ~30% take-up of current registered users
- Running both apps in parallel is probably best in the short term, and maybe in the long term, but probably not much better once you reach 50% take-up

Some quick questions / comments

1. Does this take into account the fact that some users of COVIDSafe today have not updated the app to take advantage of the Bluetooth enhancements in v1.2 ?
2. Minor stylistic preference – but when referring to the existing app as V1 this might confuse because that sounds like the first version of the app, and we've had a few release since the initial version – maybe we could change the reference to something else, like Current v. ENF
3. P4 – first paragraph, last bullet point says 'but users with different families', .. not sure what you mean
4. Maybe change reference of true contacts to 'true close contacts' given that's what we are testing effectiveness for

Do you expect this to change much even after we do the test after the apps are asleep for 2+ hours?
I would have thought not.

Cheers
s 47F

—

s 47F
s 47F

From: s 47F
Sent: Wednesday, 17 June 2020 9:36 PM
To: s 47F >

Subject: DRAFT summary of ENF

Hi s 47F - I think s 47F has spoken with you about how the 'missing iOS' issue makes a large difference to the result - it strongly strengthens the case for investigating ENF. I've now reflected this in the analysis and writeup attached. This is a first draft, and for the sake of speed, you and s 47F are the first to see it now. I'd very much appreciate all comments and improvements!

s 47F

—

s 47F
[redacted]
Sydney, Australia

s 47F
[redacted]

From: s 47F
To: s 47F
Cc: s 47F
Subject: Re: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]
Date: Wednesday, 1 July 2020 4:51:50 PM
Attachments: image001.png
image002.png
image003.png
image004.png
image005.png

Hi s 47F

Do you want us to work with s 47F to help with this?

Cheers

s 47F

On 1 Jul 2020, at 12:00 pm, s 47F > wrote:

OFFICIAL

Thanks gents for the responses. The approach below looks good. Let's get working on this.

OFFICIAL

From: s 47F >
Sent: Wednesday, 1 July 2020 11:56 AM
To: s 47F >
Cc: s 47F
Subject: RE: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

Hi s 47F

That's a very impressive set of calibration data! s 47F and I have been answering at the same time – this is a longer version of his answer:

Yes, we should use these as a correction to our attenuations – it will make the distance calibration work better.

But it will need new testing. When I picked the thresholds I took a cautious approach, given that we don't have a device correction, so we needed to be confident of not eliminating all the true positives almost regardless of the device being used. With the correction the thresholds will need to be re-set, but it's not obvious where. If we had the apple corrections as well I could actually re-process my test results with the corrections and see where a good cut-off would lie and whether it does reduce the "noise" in the signal.

My tests were necessarily crude given the time pressure – it might actually be better NOT to use them, but instead to copy (for example) the German formula in use with Apple/Google ENF, since they're likely to have done a lot more testing.

Even then it's probably worth doing a little more testing (or reprocessing) – the link you sent talks about using a single Bluetooth channel for Android (channel 37). Unfortunately, in real world situations the channel influences the signal strength because the it determines the wavelength and this determines how the signal which bounces from the floor interacts with the one which travels directly – the phone sees the aggregate signal. I suspect this impact is much smaller than things like handbags and phone cases, but I'd want to either do new end to end tests or at the very least re-process my tests with the new limits to check they come out about right.

Best wishes
s 47F

—

s 47F
[redacted]

<image001.png>

From: s 47F [redacted]
Sent: Wednesday, 1 July 2020 11:30 AM
To: s 47F [redacted]>
Cc: s 47F [redacted]>
Subject: Algorithm and Exposure Notification Framework [SEC=OFFICIAL]

OFFICIAL

Morning s 47F ,

Firstly, I wanted to thank you for you hard work on the latest update to the 15+ minute rule implementation within the COVIDSafe Health Portal. I also wanted to let you know that following approval by the (many) relevant authorities, the new algorithm is set to be released to production this Friday. I imagine this work will provide significantly improved outcomes for contact tracers and I'm very much looking forward to seeing the results.

Secondly, I wanted to bring to your attention updated information regarding the Apple/Google Exposure Notification Framework, which is almost identical to ours. s 47F [redacted] from Delv sent me the following link this morning, that discusses the Apple/Google formula with the addition of device calibration.

https://developers.google.com/android/exposure-notifications/ble-attenuation-overview

Further, Google has listed almost 10,000 Android devices with their calibration values for incorporation into the formula, as we were looking to do with data from GSMA. Google has also

mentioned it's working to get calibration information for Apple devices.

I was hoping to get your take on implementing the formula from Apple/Google and if there is anything you think we should be aware of before attempting to implement?

Thanks
s 47F

s 47F
Digital Delivery and Corporate Division
Digital Transformation Agency (DTA)
Australian Government
P s 47F
E s 47F
www.dta.gov.au

<image002.png>
<image003.png>

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<image005.png>

The DTA acknowledges Traditional Owners of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respect to Aboriginal and Torres Strait Islander cultures, and to Elders both past and present

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From: s 47F
To: s 47F
Subject: RE: DRAFT summary of ENF
Date: Wednesday, 17 June 2020 10:50:10 PM
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image001.png

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s 47F
[redacted]
Sydney, Australia

s 47F [redacted]