COVID-19 Mobile Applications

Drexel Health Tracker App

May 2020

ISSUED BY

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Introduction

Given the challenges and widespread impact of the coronavirus pandemic, new mobile applications are being developed worldwide to address the complex issues with contract tracing and managing care. The objective of this research report is to provide a comprehensive review of the COVID-19 mobile applications currently offered in the marketplace or in development. The findings from this research could provide key performance indicators on benchmarking the new Drexel Health Tracker App with other COVID-19 related apps as well as recommendations.

Questions considered include the following:

1. Who is developing and offering COVID-19 contact tracing apps in the marketplace?
2. What type of solutions do the apps provide?
3. What contact tracing technology are the apps using?
4. Do the apps offer real time updates across the organization and ability for people to track their symptoms?
5. What unique features does the App have?
6. What data can be measured and where is this information being transmitted and stored?

Industry Review

Current Solutions

COVID-19 mobile applications are currently using two different types of technology for contact tracing: GPS and Bluetooth. GPS tracking is the more well-known and popular technology, although experts agree that the lack of precision it affords makes it a poor resource in contact-tracing. Bluetooth, however, has several advantages over GPS tracking in terms of precision and privacy.

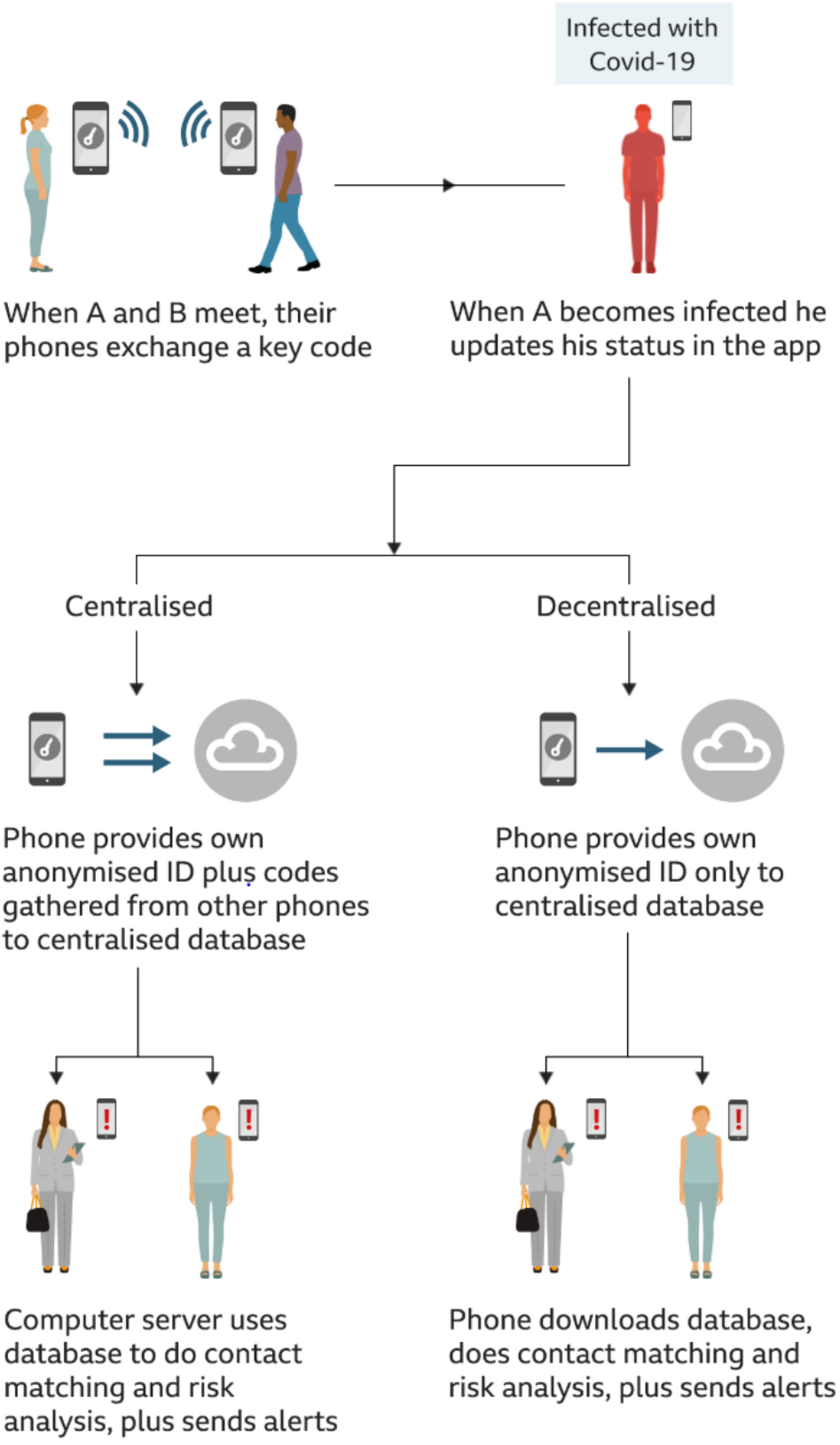
When two Bluetooth-enabled mobile devices come within range of each other, each device creates a unique ID (string of code), that it shares with the other. Every phone logs the IDs of all the phones it has communicated with and stores them.

When an individual tests positive for the virus, they can update their information on the application and share the log of all the IDs they have come in contact with, to a centralized server. Other devices will periodically check the databases uploaded onto this server to see if any of the COVID-19 positive device IDs match with those already recorded on their own logs. If a match is discovered, the application will notify the individual that he/she has come into close proximity with a COVID-19 carrier.

Proponents of the technology have stated that it is more private than sharing one's GPS location data with a third party, in that the device IDs are void of any personal information. Moreover, since Bluetooth works via a pairing protocol, the signal strength between two devices can be used to determine how close, or far away, someone was to a carrier. GPS technology, however, does not offer the kind of accuracy that Bluetooth does.

For example, if someone comes into contact with a COVID-19 carrier on a train, Bluetooth technology will be able to determine, to a higher degree, where that person was located within the train car. GPS tracking may only be able to determine that a COVID-19 carrier was present in the train car.

Centralized vs Decentralized Data Storage



Current Apps:

TraceTogether

Made By: Singapore Government

Website: https://www.tracetogether.gov.sg/

Solution Type: Bluetooth tracing

Solution Details: Singapore released an app that tracks, via Bluetooth, when two app users have been in close proximity. When a person reports they have been diagnosed with COVID-19, the app allows the Ministry of Health to determine anyone logged near them and then a human contact tracer can call those contacts and determine appropriate follow-up actions.

Singapore's TraceTogether app protects the privacy of users from each other, however it has privacy concerns with respect to the government's access to the data. TraceTogether broadcasts random time-varying tokens as temporary IDs. Because these tokens are random and change over time, someone scanning the tokens while walking down the street will not be able to track specific users across different time points, as their tokens are constantly refreshed. Note that the length of time before refreshing a token is an important parameter of the system (too infrequent could cause privacy concerns for users, too frequent and the amount of tokens that need to be stored by the server could be vast).

The tokens are also sent to a central server. These tokens are time-varying random strings, associated with an individual for some amount of time before they are refreshed. Should an individual be diagnosed with COVID-19, the health officials will ask them to release their data on the app, which includes a list of all the tokens the app has received from nearby phones. Because the government keeps a database linking tokens to phone numbers and identities, it can link this list of tokens to the users who may have been exposed.

Using time-varying tokens, the app does keep the users private from each other. A user has no way of knowing who the tokens stored in their app belong to, except by linking them to the time the token was received. However, the app provides little to no privacy for infected individuals. After an infected individual is compelled to release their data, the Singapore government can build a list of all the other people they have been in contact with.

Real time updates across organization and ability for people to track their symptoms: Yes

Unique App Features:

1. **Established notification process:** Notified when someone has come in close contact with an individual who tested positive recently
2. **Staffed by physicians:** N/A
3. **Ensures contact tracing and managing care:** Yes

4. Ability to scale up to system level: Yes (Currently 1.4 Million Users)

Data Measured:

1. TraceTogether does not collect or use location data of any kind and does not access a user's phone contact list or address book. It only uses Bluetooth data to establish a contact and does not store information about where the contact happened.
2. No data is uploaded to the government. All data collected is stored locally on the user's phone and encrypted. In the event a person is confirmed to be infected with COVID-19, the government will then request for him/her to upload their data to facilitate contact tracing of his/her close contacts.

Pricing model: No cost for users and app development cost was not disclosed by the government.

Info Transmission and Storage: Information stays on user's cell phone unless tested positive for the virus. If tested positive, then data is uploaded on government central system.

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Close contact detector

Made By: Chinese Government

Website: N/A

Solution Type: Quick Response (QR) code on smartphones (Mandated Use)

Solution Details: The app integrates with the Ministry of Transport, China Railway, the Civil Aviation Administration, and the Chinese National Health Commission database. Once the user has entered his or her identification number, the app will alert the user with instructions to stay home and contact health authorities if the user has been in the same space as someone who has tested positive.

The success of this surveillance strategy is based on a previously existing infrastructure for monitoring the movement of people within China. The app can provide potential exposure information for the previous 2 weeks. The app is also intended to be used to determine the ability of individuals to move throughout the country, based on their exposure history.

People will be able to use the new app by scanning a QR code via mobile apps such as Alipay and WeChat. Users must provide their phone number, name, and ID number to check if they were in close contact with an infected patient. Close contact is defined as being in close distance, without any effective protection, with confirmed, suspected, or mild cases when the person was ill or had asymptomatic cases. People in China sign up through popular wallet app, Alipay, or other apps, and are assigned a color code — green, yellow or red — that indicates their health status.

As soon as a user grants the software access to personal data, a piece of the program labeled "reportInfoAndLocationToPolice" sends the person's location, city name, and an identifying code number to a server. The software does not make clear to users its connection to the police.

Real time updates across organization and ability for people to track their symptoms: Yes

Unique App Features:

1. Established notification process: Yes
2. Staffed by physicians: Yes
3. Ensure contact tracing and managing care: Yes
4. Ability to scale up to system level: Currently used by Millions in China

Data Measured: Person's location, city name, and an identifying code number

Pricing model: No charge for users

Info Transmission and Storage: It appears to share information with the police, setting a template for new forms of automated social control that could persist long after the epidemic subsides. Centralized storage system, government and police have complete access to the data.

The Corona Map and Corona 100m

Made By: Ministry of the Interior and Safety (South Korea)

Website: N/A

Solution Type: Geo Location (GPS) + Camera footage and credit card transactions of confirmed COVID-19 patients to recreate their routes.

Solution Details: South Korea is sending real-time alerts via text message, apps and online on the number of confirmed cases of coronavirus (COVID-19) as well as the travel histories of those infected.

The Corona 100m (Co100) app, was launched on February 11th and using government data, alerts users when they come within 100 meters of a location recently visited by an infected person. It had a million downloads in its first ten days after launch, according to the South Korean government website Korea.net, which said the app "allows users to conveniently avoid potentially dangerous locations without checking the travel histories of those infected".

South Korea early on created a public database of coronavirus cases that provides comprehensive and detailed information about every infected individual, including their exact movements around the country.

Meanwhile, the Coronamap website shows the travel histories of confirmed COVID-19 patients and the Corona app aims to function "like a search engine" for information on coronavirus-hit areas. According to reports, the communications do not identify patients individually but provide their gender and age range and assign them a case number.

Real time updates across organization and ability for people to track their symptoms: Yes

Unique App Features:

1. **Established notification process:** Yes
2. **Staffed by physicians:** N/A
3. **Ensure contact tracing and managing care:** Yes
4. **Ability to scale up to system level:** Currently 1 Million Downloads

Data Measured: Geo Location, Credit Card Transactions, CCTV, Gender, Age, Case Number

Pricing model: No charge for users

Info Transmission and Storage: South Korea Government

Covid Watch App

Made By: Covid Watch, a nonprofit with a team of 400 volunteers, academic partners (Stanford University, University of Waterloo), and collaborator partners including TCN coalition, CoEpi, and OpenMined.

Website: https://www.covid-watch.org/about

Solution Type: Bluetooth tracing

Solution Details: App uses bluetooth signaling to detect other users in the area and will alert users anonymously if they were in contact with someone who was confirmed to be infected with COVID-19. The data is collected voluntarily and is anonymized.

The goal of the app is a 3-pronged approach: (1) contact tracing with automated alert of contacts based on shortrange Bluetooth signaling; (2) heatmaps based on anonymized GPS data on locations of higher concentrations of cases to identify high risk areas for transmission; and (3) generation of risk reduction strategies for health practitioners based on the data.

Real time updates across organization and ability for people to track their symptoms: N/A

Unique App Features:

1. **Established notification process:** Yes
2. **Staffed by physicians:** No
3. **Ensure contact tracing and managing care:** Yes
4. **Ability to scale up to system level:** N/A

Data Measured: Geo Location

Pricing model: No Charge for users.

Note: Developing an app in US using Bluetooth or GPS technology typically costs between $5000 - $10,000. Bluetooth Apps are cheaper to develop and a basic app can cost around $5000, whereas GPS apps are far more expensive and a basic app can cost upwards of $10,000.

Info Transmission and Storage: Information stored on Users device

CoEpi (Community Epidemiology in Action)

Made By: Open Source Application

Website: https://www.coepi.org/vision/

Solution Type: Bluetooth Proximity

Solution Details: CoEpi is a privacy-first system for anonymous Bluetooth proximity-based exposure alerting based on voluntary symptom sharing. By installing CoEpi and reporting symptoms, the user and the people the user interacts with can create their own early warning system to detect and respond to any infectious disease.

Users are able to:

- Install the app without disclosing any personal information.
- Enable or disable tracking their location history (only locally on their own device) on a scheduled, geofenced, or manual basis to avoid collecting any sensitive information.
- Enable or disable on-demand or background scanning for other compatible app users nearby using Bluetooth Low Energy (BLE), and recording (only on the local device) the history of other devices seen by the app.
- Produce a report on the device which shows a timeline of personal location history, likely as either a timeline or a map. This report should be able to be emailed or printed on user request. The use case of for this report is for the application for individual health care, and in manual contact tracing activity should an individual wish to still contribute to community good after diagnosis but decline to use the networked methodology below.
- When users come into close range for an extended period of time, and if both users consent, the app allows them to register a close-contact connection between the devices, allowing either user to preferentially share more information with trusted close contacts than with acquaintances.

Real time updates across organization and ability for people to track their symptoms: Yes

Unique App Features:

1. **Established notification process:** Be alerted, via push notification or by periodic anonymous polling, when another CoEpi user who has shared symptoms, was nearby at any point when they may have been contagious.
2. **Staffed by physicians:** N/A
3. **Ensure contact tracing and managing care:** Yes, track their own respiratory or gastrointestinal symptoms. The app will optionally prompt the user for additional updates on symptom progression, providing the user with a comprehensive illness history if the symptom progress to the point of requiring medical attention.
4. **Ability to scale up to system level:** Currently in development stage

Data Measured: (Consent required) Location, healthcare data, identity if tested positive

Pricing model: N/A

Info Transmission and Storage: Users Phone

Private Kit: Safe Paths

Made By: Massachusetts Institute of Technology (MIT)

Website: https://safepaths.mit.edu/

Solution Type: Geo Location, Mobile and Web Based, Bluetooth

Solution Details: Open source technology that enables jurisdictions and individuals to maximize privacy, while also maximizing the effectiveness of contact tracing in the case of a positive diagnosis. The Safe Paths platform, currently in beta, comprises both a smartphone application, PrivateKit, and a web application, Safe Places.

The PrivateKit app will enable users to match the personal diary of location data on their smartphones with anonymized, redacted, and blurred location history of infected patients. The digital contact tracing uses overlapped GPS and Bluetooth trails that allow an individual to check if they have crossed paths with someone who was later diagnosed positive for the virus.

Through Safe Places, public health officials are equipped to redact location trails of diagnosed carriers and thus broadcast location information with privacy protection for both diagnosed patients and for local businesses.

Real time updates across organization and ability for people to track their symptoms: Yes

Unique App Features:

1. **Established notification process:** Yes
2. **Staffed by physicians:** N/A
3. **Ensure contact tracing and managing care:** Yes
4. **Ability to scale up to system level:** Under Development

Data Measured: Geolocation, Heat Maps. Data is never decrypted, only downloads location trails of infected people and reveals data to public only in encrypted and redacted versions.

Pricing model: N/A

Info Transmission and Storage: Users Phone

PACT: Private Automated Contact Tracing

Made By: MIT Computer Science and Artificial Intelligence Laboratory (CSAIL), MIT Internet Policy Research Initiative, Massachusetts General Hospital Center for Global Health and MIT Lincoln Laboratory. It includes close collaborators from Boston University, Brown University, Carnegie Mellon University, the MIT Media Lab, the Weizmann Institute and a number of public and private research and development centers.

Website: https://pact.mit.edu/

Solution Type: Bluetooth Low Energy (BLE)

Solution Details: PACT is a **technical standard/specification that any individual can deploy on a smartphone.** PACT's mission is to enhance contact tracing in pandemic response by designing exposure detection functions in personal digital communication devices that have maximal public health utility while preserving privacy. The PACT effort began in mid-March 2020 with the development of the PACT protocol specification, which is a simple, decentralized approach for using personal digital communication devices for automating exposure detection using Bluetooth Low Energy signaling. Version 0.1 of the PACT protocol was released on 8 April 2020. The Apple and Google plan for exposure notification services are largely consistent with the PACT protocol and were released shortly afterwards. Initial proof of concept technology demonstrations were completed by MIT around the same time.

Proximity Detection Efficacy:
Collect the experimental data required to demonstrate and evaluate objectively and quantitatively the extent to which Bluetooth Low Energy (BLE) can be used to detect when two people have been closer than some medically relevant distance from each other for too long a period of time, i.e. "too close for too long" (TC4TL). Collect BLE data (and related metadata) to find the best way to compute TC4TL and measure TC4TL performance (using receiver operating characteristic curves, decision cost functions, etc.)

Determine how performance depends on various equipment, user and environmental factors and measure the impact that different approaches for computing TC4TL have on smartphone battery life and compute resources. Assess the exposure notification software developed and distributed by Apple and Google ("A|G").

Recommend improvements to the A|G approach where appropriate. Share all results openly and explain the implications to public health authorities (PHAs), A|G and others to inform decision-making. Simultaneously begin investigation of other signaling protocols (e.g. ultrasound, UWB) in case BLE communication is shown to have insufficient efficacy.

Real time updates across organization and ability for people to track their symptoms: N/A

Unique App Features:

1. **Established notification process:** Yes
2. **Staffed by physicians:** Health providers are authorized to make a positive diagnosis that an individual has COVID-19, based on a positive test or an evaluation of symptoms
3. **Ensure contact tracing and managing care:** Yes

4. Ability to scale up to system level: Currently in Pilot Stage. As warranted from the experimental results, PACT may deploy a prototype system for a limited period of time to some select organizations in operational settings, help them use it, collect and assess all relevant data, and try to evaluate the system's public health and privacy efficacy. We will use the resulting experience to improve the functionality and relevance of the prototype, to validate our analysis and to broaden and deepen our understanding of the problem.

Data Measured: PACT will conduct a series of hypothesis-driven experiments of increasing fidelity in the following order: constructive, virtual, and live. These experiments will help validate the predictive power of the models developed in system analysis.

Pricing model: N/A

Info Transmission and Storage: There is some privacy loss when a diagnosed individual participates in the tracing layer. Anybody who comes into close proximity of the diagnosed individual can recognize when the chirp they received from the diagnosed individual appears later in the exposure database. If they additionally remember the people nearby when receiving that chirp (e.g., by taking a photograph), then they may be able to re-identify the diagnosed individual. Furthermore, because each seed can be used to link all chirps transmitted within a one-hour period, multiple contacts could collectively reconstruct the partial movement pattern of the diagnosed individual by combining the chirps they received. It is emphasize that the diagnosed individual retains full privacy against non-contacts; in particular, the diagnosed individual's healthcare and location information cannot be recovered solely from the exposure database.

PACT is designed to be public since it only contains lists of randomly generated seeds to provide to all other users. It relies on the exposure database in two ways. First, the database maintainer should not maintain any logs regarding the identities of the diagnosed users who uploaded information; alternatively, the application can perform the uploading over an anonymous network communication system like Tor. Second, the database maintainer should not work with the testing authority to link diagnosed users with the permission numbers that they submit.

CovidSafe

Made By: Australia Government

Website: https://www.health.gov.au/resources/apps-and-tools/covidsafe-app

Solution Type: Similar to Singapore App "Trace Together" – Uses Bluetooth

Solution Details: Same as Trace Together and any other Bluetooth tracing app.

Real time updates across organization and ability for people to track their symptoms: Yes

Unique App Features:

1. **Established notification process:** Yes
2. **Staffed by physicians:** Yes
3. **Ensure contact tracing and managing care:** Yes
4. **Ability to scale up to system level:** 4 Million current users. The government's target for uptake of the app is 40% of the population (24 Million Total Australia Population).

Data Measured: Same as Trace Together

Pricing model: The total cost of the app for the government is $1.5m, including over $700,000 for Amazon to host the data.

Info Transmission and Storage: Stored in AWS government owned cloud storage for all people who have been tested positive and opted to store their data in government cloud.

Privacy-Preserving Contact Tracing

Made By: Google and Apple

Website: https://www.apple.com/covid19/contacttracing

Solution Type: Bluetooth

Solution Details: Google and Apple are announced a joint effort to enable the use of Bluetooth technology to help governments and health agencies reduce the spread of the virus, with user privacy and security central to the design.

Apple and Google will be launching a comprehensive solution that includes application programming interfaces (APIs) and operating system-level technology to assist in enabling contact tracing. Given the urgent need, the plan is to implement this solution in two steps while maintaining strong protections around user privacy.

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

Second, in the coming months, Apple and Google will work to enable a broader Bluetooth-based contact tracing platform by building this functionality into the underlying platforms. This is a more robust solution than an API and would allow more individuals to participate, if they choose to opt in, as well as enable interaction with a broader ecosystem of apps and government health authorities. Privacy, transparency, and consent are of utmost importance in this effort and the company will publish information about the work for others to analyze.

Both phases of the solution harness the power of Bluetooth technology to aid in exposure notification. Once enabled, users' devices will regularly send out a beacon via Bluetooth that includes a random Bluetooth identifier — basically, a string of random numbers that are not tied to a user's identity and change every 10-20 minutes for additional protection. Other phones will be listening for these beacons and broadcasting theirs as well. When each phone receives another beacon, it will record and securely store that beacon on the device.

At least once per day, the system will download a list of the keys for the beacons that have been verified as belonging to people confirmed as positive for COVID-19. Each device will check the list of beacons it has recorded against the list downloaded from the server. If there is a match between the beacons stored on the device and the positive diagnosis list, the user may be notified and advised on steps to take next.

Real time updates across organization and ability for people to track their symptoms: N/A

Unique App Features:

1. **Established notification process:** Yes
2. **Staffed by physicians:** Yes
3. **Ensure contact tracing and managing care:** Yes
4. **Ability to scale up to system level:** Yes

Data Measured: Each user will have to make an explicit choice to turn on the technology. It can also be turned off by the user at any time. This system does not collect location data from the user's device and does not share the identities of other users to each other, Google or Apple. The user controls all data they want to share, and the decision to share it.

Random Bluetooth identifiers rotate every 10-20 minutes, to help prevent tracking. Exposure notification is only done on device and under the user's control. In addition, people who test positive are not identified by the system to other users, or to Apple or Google. The system is only used for contact tracing by public health authorities' apps. Google and Apple will disable the exposure notification system on a regional basis when it is no longer needed.

Access to the technology will be granted only to public health authorities. Their apps must meet specific criteria around privacy, security, and data control. The public health authority app will be able to access a list of beacons provided by users confirmed as positive for COVID-19 who have consented to sharing them. The system was also designed so that Apple and Google do not have access to information related to any specific individual.

Pricing model: N/A

Info Transmission and Storage: If a user decides to participate, exposure notification data will be stored and processed on device. Other than the random Bluetooth identifiers that are broadcast, no data will be shared by the system with public health authority apps unless one of the following two scenarios takes place:

If a user chooses to report a positive diagnosis of COVID-19 to their contact tracing app, the user's most recent keys to their Bluetooth beacons will be added to the positive diagnosis list shared by the public health authority so that other users who came in contact with those beacons can be alerted.

If a user is notified through their app that they have come into contact with an individual who is positive for COVID-19 then the system will share the day the contact occurred, how long it lasted and the Bluetooth signal strength of that contact. Any other information about the contact will not be shared.

In keeping with their privacy guidelines, Apple and Google will not receive identifying information about the user, location data, or information about any other devices the user has been in proximity of.

COVID Symptom Tracker & HowWeFeel

Made By: Harvard University and co-collaborators

Websites:
https://covid.joinzoe.com/us
https://howwefeel.org/

Solution Type: COVID Symptom Tracker provides health services by providing a tool to users to track their symptoms. This app works similarly to the Drexel Health Tracker App. Helps track the onset and progression of COVID-19 symptoms of millions across the U.S., with the goal of shedding light on the nature of the disease, identifying those at risk sooner, pinpointing virus hot spots, and helping slow the spread of disease.

Collaborators include Harvard T.H. Chan School of Public Health, Massachusetts General Hospital, King's College London, and Stanford University School of Medicine, in collaboration with the health science company ZOE.

HowWeFeel Pinpoints COVID-19 hot spots, predicts areas that could soon see spikes in COVID-19 cases, sheds light on pertinent risk factors and demographic information, and allows health agencies to better respond to the pandemic

Collaborators: Harvard T.H. Chan School of Public Health, Harvard University, Massachusetts Institute of Technology, the Broad Institute of MIT and Harvard, the Weizmann Institute of Science, the University of Pennsylvania, Stanford University, the University of Maryland School of Medicine, Howard Hughes Medical Institute, Weill Cornell Medicine, and Ben Silbermann, CEO Pinterest

Solution Details: Same as Trace Together and any other Bluetooth tracing app.

Real time updates across organization and ability for people to track their symptoms: Yes

Unique App Features:
1. **Established notification process:** Yes
2. **Staffed by physicians:** Yes
3. **Ensure contact tracing and managing care:** Yes
4. **Ability to scale up to system level:** Current downloads COVID Symptom Tracker: 3,733,094

Data Measured:
- **Covid Symptom Tracker:** Age, gender, height and weight, zip code, possible exposure to others with COVID-19, health conditions, medications, daily symptoms, COVID-19 testing
- **HowWeFeel:** Age, gender, zip code, health conditions, daily symptoms, COVID-19 testing, social distancing

Pricing model: N/A. HowWeFeel app is available to everyone in the U.S. who is 18+

Info Transmission and Storage: Scientists and doctors will use the data to identify new outbreaks, understand how the virus is spreading, discover new populations that may be at risk, and evaluate how interventions are working to slow the spread of the disease.

The data submitted by the user is aggregated and shared with doctors, scientists, researchers and public health professionals who are working to stop the COVID-19 pandemic. Every individual or organization who applies to access the aggregated data is screened first.

Personal information such as name, phone number or e-mail address is not requested or collected. Users are not asked to create an account or log in through other accounts. All data is securely shared only with organizations actively working to fight the spread of COVID-19.

Conclusion:

There are many responses to COVID-19 including protecting the vulnerable, building new protocols for daily life to reduce transmission, and containing inevitable local outbreaks of coronavirus. Testing and contact tracing will be critical to this last strategy, especially, in light of the high transmission rate of COVID-19. Exposure notification can be a key addition to the toolbox of public health authorities. As the response to the pandemic evolves, technological solutions will need to continue to adapt as well so the efforts of public health authorities can be amplified.

The two main contact tracing tools are Bluetooth and GPS tracing. GPS tracing generates a heat map of people's location whereas Bluetooth generates a token which interacts with other tokens near it. Both tracing tools have some limitations: GPS does not track close proximity contact with 100% accuracy and Bluetooth consumes a lot of the device battery when switched On. Hence the use of BLE (Bluetooth Low Energy) is being used by most of the app developers.

The storage of data is also a significant concern. In the US, people are more protective about their data and are not open to sharing their data with healthcare or governments. People in Asia and Australia have far more trust in their respective governments to protect user data and use data for contact tracing. These regions have shown significant decline in Covid-19 cases since the inception of the Bluetooth Contact tracing apps and the apps are widely being used by millions of people. The data is primarily stored on users' phones and the data is only shared with public health organizations when someone has tested positive for the virus. Some apps store the data in a centralized system, which is governed by the government or a private organization. This is where anti-trust issues emerge in US and needs to be addressed by the governing body.

Most of the apps in the US are currently in the development stage and have not been used on a wide scale. Only the apps in Asia and other parts have been in public use since March 2020. Currently, there is no data on how useful the US apps will be, but the baseline technology is the same in all the apps.

Drexel Health Tracker App is currently being used by Drexel's health department and only works on an iPhone and other Apple devices. Integration with Android devices and/or a web-based portal would provide ability for more comprehensive and wider use. A strong back-end team would enable the app to regularly update the database daily. Users should be educated in terms of how to use the app and the importance of digital contact tracing to reduce Covid-19 infections. Use of Bluetooth or GPS for contact tracing may be a feature of interest in future in addition to its existing symptom tracker.

Additional Resources

CDC Guidelines for app development:

https://www.cdc.gov/coronavirus/2019-ncov/php/open-america/contact-tracing-resources.html

https://www.cdc.gov/coronavirus/2019-ncov/downloads/digital-contact-tracing.pdf

https://www.cdc.gov/coronavirus/2019-ncov/downloads/php/prelim-eval-criteria-digital-contact-tracing.pdf

John Hopkins:

https://www.centerforhealthsecurity.org/resources/COVID-19/COVID-19-fact-sheets/200408-contact-tracing-factsheet.pdf

PACT: Private Automated Contact Tracing:

https://pact.mit.edu/wp-content/uploads/2020/05/PACT-Mission-and-Approach-2020-05-19-.pdf

https://pact.mit.edu/wp-content/uploads/2020/04/The-PACT-protocol-specification-ver-0.1.pdf

Contact Tracing Mobile Apps for COVID-19: Privacy Considerations and Related Trade-offs:

https://arxiv.org/abs/2003.11511

MIT:

https://www.media.mit.edu/projects/safepaths/overview/

Additional Links:

https://www.timesnownews.com/technology-science/article/could-apple-and-googles-joint-venture-using-bluetooth-be-a-gamechanger-against-covid/595636

https://www.businessinsider.com/coronavirus-south-korea-tech-contact-tracing-testing-fight-covid-19-2020-5#the-government-is-also-stockpiling-infrared-cameras-to-detect-fevers-along-with-other-medical-equipment-4

https://www.aljazeera.com/news/2020/04/korea-smartphone-apps-tracking-coronavirus-won-stop-buzzing-200408074008185.html

https://foreignpolicy.com/2020/05/12/coronavirus-tracking-tracing-apps-cant-work-south-korea-singapore-australia/

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

https://www.apple.com/covid19/contacttracing