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Research Article

Contact Tracing Tool of COVID -19 for India and Ethiopia using Blue-trace Protocol in Android Mobile

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Abstract

Contact tracing is an important tool for reducing the spread of infectious diseases. Its goal is to reduce a disease's effective reproductive number (R) by identifying people who have been exposed to the virus through an infected person and contacting them to provide early detection, tailored guidance, and timely treatment. By stopping virus transmission chains, contact tracing helps "flatten the curve" and reduces the peak burden of a disease on the health-care system. Contact tracing forms an essential part of Ethiopia and India response to the COVID-19 pandemic. This proposed technical specification for a new privacy-preserving Bluetooth protocol is used to support Contact Tracing and makes it possible to combat the spread of the COVID-19 virus by alerting participants of possible exposure to someone who they have recently been in contact with, and who has subsequently been positively diagnosed as having the virus. The Contact Detection Service is the medium for contact tracking and uses the Bluetooth LE (Low Energy) for nearby smart-phone proximity detection and data sharing mechanisms. Technology (BLE), which has been available in today's smart phones for many years, has proven to be the only way to determine the proximity to other smart phones. In our proposed model, firstly we developed the tracing cloud function and android app which is a privacy-preserving protocol for community-driven contact tracing across borders. It allows participating devices to log Bluetooth encounters with each other, in order to facilitate epidemiological contact tracing while protecting users' personal data and privacy, finally We developed Tracing calibration data and trial methodologies for testing implementations of Bluetrace protocol.

Keywords: Bluetooth LE, COVID 19 contact tracing, Blue-trace protocol

1. Introduction

Contact tracing, the identification and follow-up of individuals who have had contacts with infectious individuals, is a critical process to ensure the best possible chance of control and the longest possible time to local take-off [9]. Contact tracing and follow-up control measures such as quarantine and isolation were crucially important during the SARS outbreak in 2003 [10], the Ebola outbreak in Africa in 2014 , as well as its part in the eradication of smallpox. With current advances in vaccine development technologies, the role of contact tracing and follow-up control measures in the initial stage of an epidemic becomes especially important. For some novel

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pathogens such as pandemic influenza, cutting-edge technology may shorten the time needed for vaccine development after initial isolation, bridging shorter gaps between epidemic emergence and vaccine availability.

Contact tracing is a significant tool to reduce infectious disease spread. Its objective is to reduce t he effective reproductive number (R) of the disease by identifying and contacting people who have been exposed to the virus through an infected person to provide early detection, tailored guidance and timely treatment.By preventing the transmission chains of viruses, touch tracing helps to "flat ten the curve" and reduces the disease's peak burden on the healthcare system. Contact tracing is an integral part of the response of Ethiopia to the COVID-19 pandemic.Our goal is to create a CO VID19-Contact Tracing (CCT) tool for Ethiopia and India using Bluetooth LE (Low Energy) to detect proximity to nearby smart-phones.An important tool for public health authorities and local communities t o tackle the spread of emerging pathogens, such as the COVID-19 pandemic.Its designed to help h ealth officials monitor exposures after an infected person is detected.

2. Related Works

Three large-scale outbreak in human populations triggered by emerging corona viruses (Co-Vs) occurred in the 21st century: Severe Acute Respiratory Syndrome (SARS) outbreak in 2003; Middle East Respiratory Syndrome (MERS) outbreak in 2012 primarily in the Saudi Arabia Peninsula regi on of Middle East; and MERS outbreak in 2015, primarily in South Korea. Since their emergence, World Health Organization (WHO) had been notified of more than 8000 confirmed cases of SARS in 26 countries [1] and more than 2200 confirmed cases of MERS in 27 countries [2]. SARS and MERS were both considered as “fast-course” infectious diseases given their relatively short infectious period. However, overall transmission potential for MERS is lower compared to SARS [3] and its outbreaks have been contained with much lower cumulative numbers of infected individuals than was the case for SARS. Prior studies showed that human-to-human transmission of SARS occurred via close contact and respiratory droplets [4], while that of MERS occurred via close contact only [5]. A large proportion of MERS cases were clustered in healthcare settings, most of which were contributed by unprotected close contact between healthcare workers and infected MERS patients. The majority of SARS cases occurred among healthcare workers; while substantial number of MERS cases were patients [3], with most MERS severe cases and mortality being individuals with comorbidities [6]. On the other hand, there were similarities between the two Co-Vs. Diseases caused by them were deadly, with a mortality rate of 29.8% for MERS [6] and 7% for SARS. In light of this, we conducted a systematic review of mathematical models for contact tracing and follow-up control measures of SARS and MERS transmission. The aims of this review are to (i) provide an overview of contact tracing and follow-up control measures of SARS and MERS transmission gained through mathematical modelling, (ii) to identify future research direction in this area and (iii) to improve future models by addressing current models' deficiencies.

In December 2019, a new virus (initially called ‘Novel Corona virus 2019- CoV’ and later renamed to SARS-CoV-2) causing severe acute respiratory syndrome (corona virus disease COVID-19) emerged in

Wuhan, Hubei Province, China [1], and rapidly spread to other parts of China and other countries around the world, despite China's massive efforts to contain the disease within Hubei. Compared to the 2002/2003 SARS-CoV and the 2012–2014 MERS-CoV (Middle East Respiratory Syndrome-related corona virus), the COVID-19 corona virus spread strikingly fast. While MERS took about two and a half years to infect 1000 people, and SARS took roughly 4 months, the novel SARS-CoV-2 reached that figure in just 48 days. On 30 January 2020, the World Health Organization (WHO) declared that the new SARS-CoV-2 corona virus outbreak constitutes a Public Health Emergency of International Concern (PHEIC) [2].

Indeed, health professionals have long considered conventional mapping, and more recently geographic information systems (GIS), as critical tools in tracking and combating contagion. The earliest map visualization of the relationship between place and health was in 1694 on plague containment in Italy [7]. The value of maps as a communication tool blossomed over the next 225 years in the service of understanding and tracking infectious diseases, such as yellow fever, cholera and the 1918 influenza pandemic. From the 1960s, when computerized geographic information systems were born, the possibilities for analyzing, visualizing and detecting patterns of disease dramatically increased again. A 2014 review of the health GIS literature found that 248 out of 865 included papers (28.7%) focused on infectious disease mapping [8]. Since then we have seen a revolution in applied health geography through Web-based tools [9, 10]. Now, as we deploy these tools to protect human lives, we can ingest big data from their sources and display results in interactive and near-real-time dashboards. These online dashboards have become a pivotal source of information during the COVID-19 outbreak.

This paper offers pointers to, and describes, a range of practical online/mobile GIS and mapping dashboards and applications for tracking the corona virus epidemic and associated events as they unfold around the world. Some of these dashboards and applications are receiving data updates in near-real-time (at the time of writing), and one of them is meant for individual users (in China) to check if the app user has had any close contact with a person confirmed or suspected to have been infected with SARS-CoV-2 in the recent past. We also briefly discuss additional ways GIS can support the fight against infectious disease outbreaks and epidemics.

3. Proposed model

We built a CCT (COVID-19 Contact Tracing) model to investigate our research, which is a protocol based on the logging of Bluetooth encounters between participating devices to facilitate contact trac ing while protecting personal data and privacy of users. When two participating devices approach e ach other, they exchange messages that are not personally identifiable, and contain temporary iden tifiers.

Frequently the identifiers rotate to prevent users from being monitored by third parties. The histor y of the user's experience is stored locally on the smart-phone of their user; the health authority ca n not directly access any of these records. If a user is compromised or is the target of touch tracing, they will be asked to share their history of experiences with the health authority concerned using a PIN.CCT is intended to complement manual contact tracing by resolving its main limitations:
an infected person can only record contacts they are familiar with and know to have encountered. Also, CCT could allow more flexible and less resource-intensive contact tracing. The CCT also allow s a federated network of health authorities to maintain separate user bases for each, thus

allowing for contact tracing between users from different health authority jurisdictions.

Contact Tracing makes it possible to battle the spread of the COVID-19 virus by alerting participan ts to possible exposure to someone they have been in touch with recently and who was subsequent ly positively diagnosed with the virus.

4. Functionality theory

User registration and assignment of User-ID

When the user of a CCT-implementing app registers with their phone number, the back-end service generates a unique, randomized User-ID and associates it with the user's phone number [Figure 1]. Phone numbers are the only personally-identifiable information required from the user. The phone numbers are used to contact users if they are found to have had prolonged exposure to an infected person.

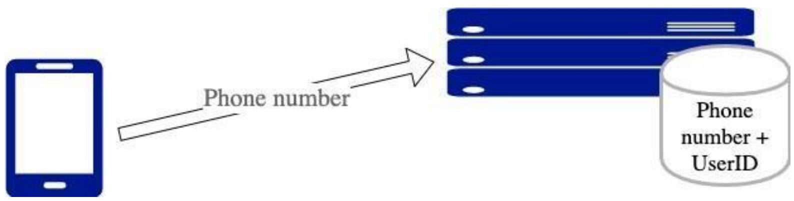

Figure 1: User registration

Generation of Temp-IDs

CCT App devices log encounters with each other by exchanging messages over Bluetooth. To protect users' privacy, these messages cannot reveal users' identity. In addition, these messages cannot contain static identifiers, to prevent users from being tracked over time by third parties. However, when an infected user uploads these messages to the health authority, the authority must be able to obtain contact information from the messages.

CCT App addresses this by having users exchange temporary IDs (Temp-IDs). Each Temp-ID comprises a User-ID, created time, and expiry time encrypted symmetrically with AES-256-GCM and then Base64 encoded [Figure 2]. Only the health authority holds the secret key to encrypt and decrypt Temp-IDs. Each Temp-ID is generated with a random Initialization Vector. The Temp-ID also includes two encryption parameters: the input and an Auth Tag (for integrity checks).

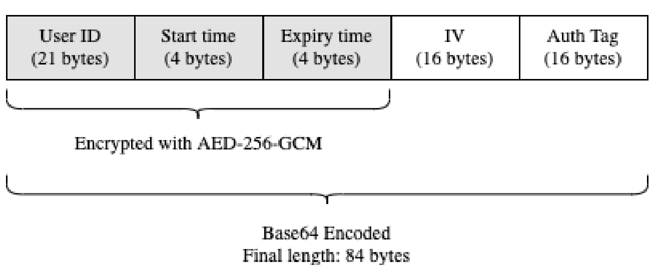

Figure 2: Format of Temp-ID

Temp-IDs have a short lifetime (we recommend 15 minutes). This helps to mitigate the impact of replay attacks, by reducing the window of opportunity for exploitation. If malicious users impersonate other users by rebroadcasting their messages, they will only be able to do so for a short time before the message expires. This duration would likely be below the threshold duration of close contact, and hence not result in false positives.

Figure 3: Temp-IDs sent to device

In order to ensure that devices have a supply of valid Temp-IDs even when the internet connection is unstable, devices pull batches of forward-dated Temp-IDs from the health authority's back-end service each time [Figure 3].

BLE handshake flow

In BLE parlance, devices can take on Peripheral or Central roles. Peripherals advertise Services, and Centrals scan for Peripherals' advertisements to connect to their Services. Services are a collection of data, such as Characteristics, which are specific data that can be exchanged between devices, through read and writes performed by a Central. The data exchanged by CCT App devices in each "handshake" is called an Encounter Message.

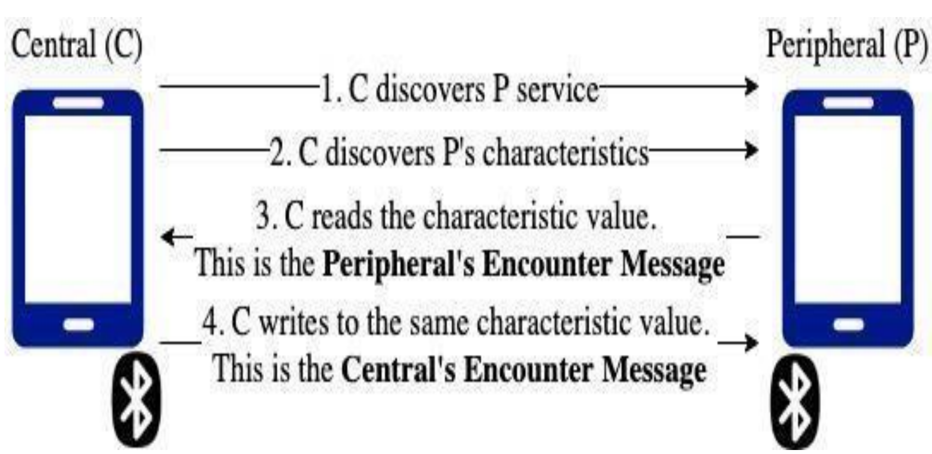

Figure 4: BLE handshake flow

Devices using CCT App act as both a Central and a Peripheral, and may alternate between these roles. When two devices connect, the Central reads the Peripheral's Encounter Message, and then writes back its own Encounter Message; each connection allows for a two-way exchange of data between the Central and Peripheral [Figure 4]. Allowing for two-way communications promotes symmetry and addresses the limitation where some devices (and possibly wearable) are only able to function as Peripherals.

Scanning and advertising cycles

CCT App devices scan and advertise on configurable cycles. Scanning occurs with a duty cycle around 15- 20%, during which devices scan for other CCT App devices as Central. Devices may optionally introduce random jitter into the length and duty ratio of each scanning cycle to avoid lockstep behavior. Advertising occurs with a higher duty cycle of around 90-100%. We recommend a shorter duty cycle for scanning to conserve resources, and the sum of both scanning and advertising duty cycles be greater than 1, to ensure that devices have the opportunity to see each other.

Blacklisting

To ensure an even distribution of Bluetooth "handshakes" with as many nearby CCT App devices as possible, CCT App devices should implement a blacklist of recently seen devices and not attempt to connect to them for the duration of the blacklist period. On Android devices, the length of this blacklist period is between one and two scanning cycles. Note that the blacklist can be negated by Peripherals that perform device identifier randomization regularly. On some Android devices, this can happen extremely frequently. Such devices tend to be scanned by Centrals repeatedly, preventing an even distribution of encounters with nearby devices. We are experimenting with different methods of preventing repetitive connections, and will incorporate recommended solutions within this document, and make the corresponding contributions to the Open-Trace reference implementation in due course.

Encounter Message

The Encounter Message is a UTF-8 encoded JSON. The fields in the JSON differ slightly depending on the direction of communication. The Peripheral's Encounter Message is advertised by the Peripheral as a Characteristic Value, so that a Central can scan for, and read it, after discovering the Peripheral and its valid Characteristic.

Storage of encounter history

Both Central and Peripheral devices store each such "handshake" as an entry in its encounter history for a certain number of days (for 21 days) before deletion. Devices can also be configured to log when a scan is performed, to differentiate between the absence of scanning and the absence of nearby devices.

Contact tracing flow

When patients have been confirmed to be infected, health authorities ask them if they have the app installed. If they do, they are asked to upload their encounter history to the health authority [Figure 5].

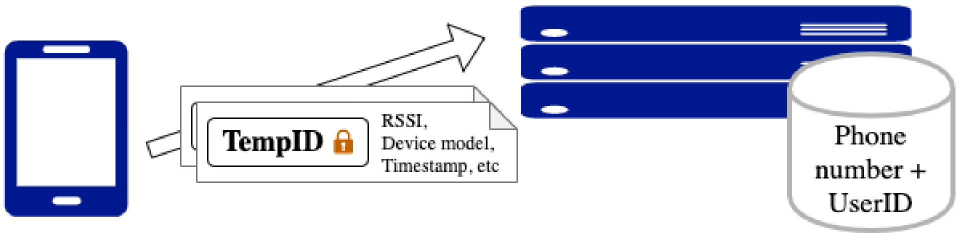

Figure 5: Upload of encounter history to health authority

To protect users and the system from fraudulent uploads, an authorization code is provided by the health authority and entered through the app in order to obtain a valid token to transmit the logs.

Data analysis flow

The health authority decrypt the Temp-ID for each encounter in the uploaded encounter history, in order to obtain the User-ID and validity period. It then verifies that the encounter timestamp for each Temp-ID falls within its validity period. The health authority then filters for close contacts based on the disease's epidemiological parameters: time of exposure (measured by the length of a continuous cluster of encounters) and distance (measured by the received signal strength reading). The health authority then contacts individuals assessed to have a high likelihood of exposure to the disease, to provide medical guidance and care. Note that this work-flow can be automated and decentralized without affecting interoperable with other CCT App implementations. However, we do not recommend this, and have therefore not implemented it in OpenTrace.

Withdrawal of consent

We believe users should be in control of their personal data and have the ability to delete this from the system. If a user withdraws consent to use their personal data, their User-ID and phone number should be deleted from the back-end database. Since the phone number is the only source of identity, deleting it will render useless all of this user's Temp-IDs that were previously sent to other device.

5. Implementation and result

OpenTrace is Blue-Trace's open source Reference Implementation. Blue-Trace is a privacy-conservi ng protocol for cross-border, community-driven communication tracing. It enables participating de vices to record each other's Bluetooth experiences to promote epidemiological communication traci ng while protecting personal data and privacy of users. The implementation of the OpenTrace Rela tion Consists of: Android app, Cloud functions and Calibration. The protocol is focused on two areas: locally logging registered users in the vicinity of a device and the transmission of the log to the operating health authority, all while preserving privacy. To achieve this, the protocol can be divided into the areas of Device to Device Communication (DDC), and Device to Reporting Server Communication (DRSC). Sequence diagram for DDC and DRSC.

As a result of implementation shows, i) first set up and register their health system information on the application. Smart phone get or generate and it provides unique Bluetooth identifier.

Figure 6: Welcome screen

Figure 7: Description screen

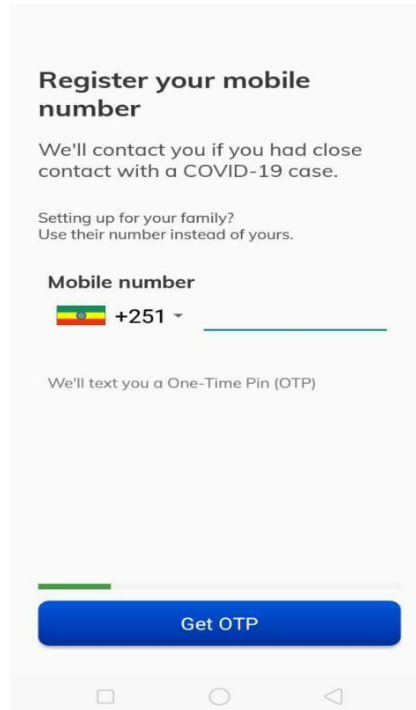

Figure 8:User Registration with Mobile number for OTP

II) And then physical contact scan: mutual Bluetooth scan and uniquely identifier exchange (Bluetooth as RFID). During scanning remote device UID, date-time are identified. III) Public space registration process: person in known public space and at least five people in victim using Bluetooth.

IV) Notification process: once a person is declared infected, health or security actor trigger the contamination process. The infected person app receive notification, give back the near physical contact stored on its smart phone or cloud to be registered in health system. His registered physical contact are notified on their device they give back near physical device. At the end of the work expected to provide the following outputs. V) Pull public space data followed: once physical contact are identified, then public location are retrieved. Once a day or less the app retrieve the infected areas. The data are checked against visited public space. In case a match is found, the app inform the user and trigger the push notification to contact with appropriate message. VI) Finally, Health system back end high level principle: health and security actor finds a list of potential infected persons. Statistical can be generated and several health system can communicate. Each user can opt in/opt out to make his or her personal data named anonymous.

6. Conclusion

Coronavirus disease (COVID-19) is a recently discovered coronavirus-caused infectious disease. Even as the WHO has declared mechanisms of prevention such as Wear a mask, clean your hands, Keep a safe distance. It was not enough to have complete control of the disease.

Contact tracing in public health is the method of identifying the person who has contact with the i nfected person and then gathering additional details about this contact. One way to cope with the disease is by monitoring the contact of infected individuals, checking them for infection, isolating or treating infected individuals and, in turn, tracking the contact to reduce population infections. To interrupt ongoing transmission and reduce the infection of COVID 19; to alert the contacts of infection and offer preventive service we studied contact tracing tool. To develop the tracing tools we used Bluetooth low energy by blue-trace protocol.

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