



Covid Community Alert - Tech Spec

Summary

Quarantine decisions and containment efforts must ground on reliable information about the probability of contagion. We have designed a mobile app and a technological platform, compliant to the European legislation, which enables de-identified contact/exposure information of users to be efficiently collected in a fully anonymous way. After a case is diagnosed, the exposure of people with the infected patient can easily be tracked back and analysed. This allows the medical and emergency management authorities to take the correct actions to alert people who may have been in close contact with an infected patient. While existing solutions rely on sensitive data based on geolocalisation, our open-source framework does not expose personal information. This is achieved by exploiting solely the anonymous data exchanged by the Bluetooth LE handshaking protocol of our smartphones. Our solution does not use sensitive data to run any of the analysis and it does not allow people to locate infected patients. The aim of this project is to give authorities the right tools to enforce the best strategy to limit the outbreaks of COVID-19 or potential future outbreaks, by allowing them to deploy solutions at scale.

The proposed solution

Covid Community Alert is an Open-Source world-level standard proposed by a global community to provide a service that allows the monitoring of interactions among devices in a totally anonymous fashion. This will help reduce the spread of the virus by alerting people at risk sending them a clear set of instructions to reduce the contagious and receive their treatments as soon as possible.

The interoperability among countries is essential to protect people when the lockdown will be over. People from all around the world will be travelling from one country to the other and we need to be able to create a world-level protocol that can accommodate all the different scenarios we could face - in the US the iPhone market share is higher than 50% and most of the proposed solutions don't work for iOS.

The open-source implementation of the proposed standard is already comprehensive of the full stack:

- Infrastructure
- Backend
- Roaming protocol
- iPhone and Android user applications (CovidApp)

Covid Community Alert

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- iPhone and Android doctor applications (CoviDoc)
- Virologist Internal Panel

We also provide the open-source code and the support to deploy the infrastructure on servers owned by each country.

Each open-source component - as well as the rules set by the virologists to identify people at risk - can be changed and adapted to different regulation or use cases that might differ from country to country.

Worldwide, with the iPhone market share at 27.03%¹, this proposal would be able to monitor 91.2-98.5% of interactions vs 71.7% of other solutions (up to 37.4% more) and ensure full anonymity and interoperability among countries.

We are currently using this service as the backbone for a constellation of other services:

- Shielding: we are integrating projects that will help to protect vulnerable people by ensuring them that other healed or not-infected people will take care of them.
- Genetic evolution of the virus: we are adding to the open-source project the possibility for the doctors to add details of the genetic information about the virus detected in the patients.

How it works:

1. Every mobile device has a unique and anonymous numeric ID, that can be read at distance using the Bluetooth LE technology.
2. Covid Community Alert continuously scans your surroundings and collects the IDs of the phones near you, storing them in a secure centralized cloud database. No interactions between the users and the app are needed.
3. Medical and emergency authorities daily update the database with the IDs of the devices belonging to confirmed Coronavirus infected individuals.
4. If you have been in the proximity of an infected person during the last 14 days you will be notified and get clear instruction on the next steps to follow, also depending on the estimated exposure to the virus from the infected person.

¹ <https://gs.statcounter.com/os-market-share/mobile/worldwide>

High-level feature description

Coverage

Our mobile application can be installed on 86% of all the Android smartphones and 97.6% of all the iPhones; this is a common restriction for Bluetooth-based technologies since they need to use the Bluetooth LE firmware.

Additional interactions detected

Our infrastructure and mobile algorithm allow us to also detect non Bluetooth-transmitting smartphones, such as iPhones.

Device of User	Surrounding devices	Can the user's device detect surrounding devices?	
		Other solutions	Covid Community Alert
Android	Android	Yes	Yes
Android	iPhone	No	Yes
iPhone	Android	Yes	Yes
iPhone	iPhone	No	<ul style="list-style-type: none">• No, if completely isolated.• Yes, if one or more Android are close to them.

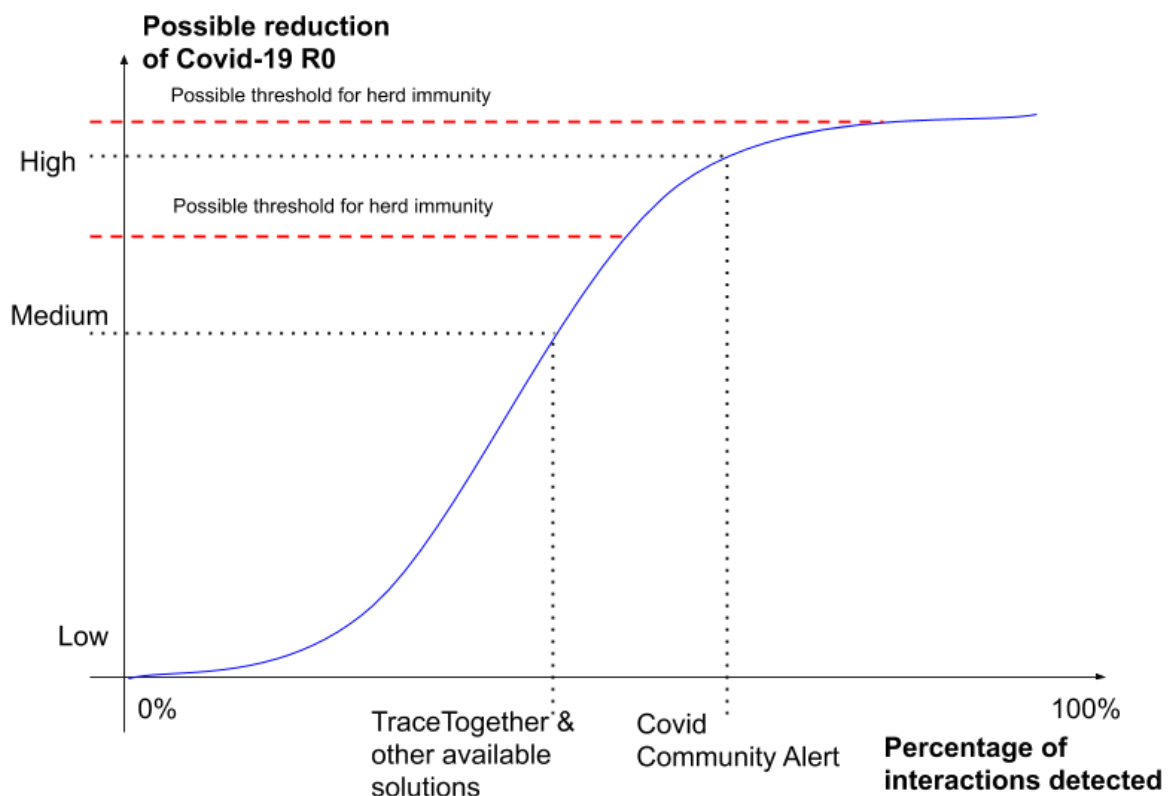
Device OS	Market Share ²
Android	72.26%
iPhone	27.03%
Others	0.71%

² <https://gs.statcounter.com/os-market-share/mobile/worldwide>

Device of User	Surrounding devices	% of total interactions	Can the user's device detect surrounding devices?	
			Other solutions	Covid Community Alert
Android	Android	52.2%	Yes	Yes
Android	iPhone	19.5%	No	Yes
iPhone	Android	19.5%	Yes	Yes
iPhone	iPhone	7.3%	No	<ul style="list-style-type: none"> No, if completely isolated. Yes, if one or more Android are close to them.
Theoretical limit:		98.5%	71.7%	91.2% - 98.5%

Technical studies show us that we can identify up to 37.4% more interactions, with respect to 71.7% relative to the rest of the solutions on the market. A linear reduction of R_0 , thanks to a higher number of interactions, has an exponential impact on the reduction of the spread of the virus.

US, and other European Countries have a remarkably higher iPhone market penetration that could lead to a significant impact on the interactions that our solution is able to anonymously monitor.



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Interoperability among countries

We provide an open-source implementation of our service that allows the monitoring of 91.2-98.5% of interactions in Europe vs 71.7% of other European solutions and ensures full anonymity.

The interoperability among countries is essential to protect people when the lockdown will be over. We'll have people from all around the world travelling from a country to the other and we need to be able to create a world-level protocol that can accommodate all the different scenarios we could face - in the US the iPhone market share is higher than 50%.

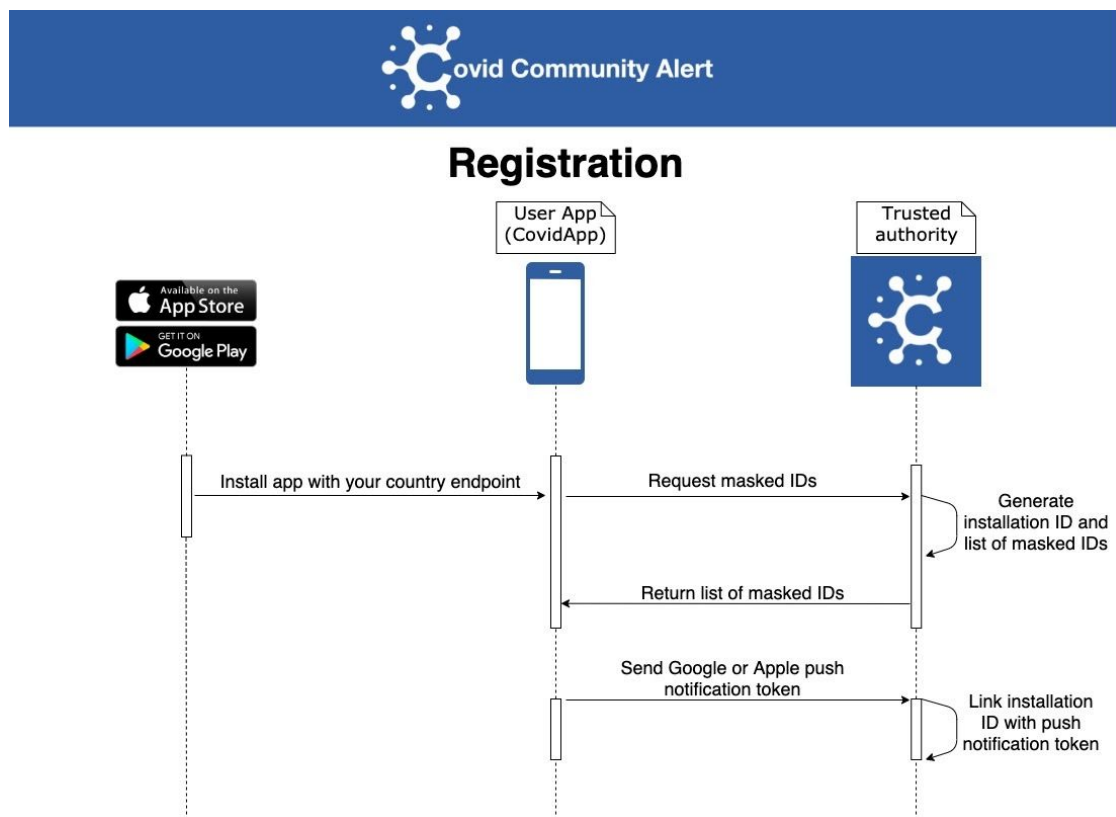
The implementation is comprehensive of the full stack:

- Infrastructure
- Backend
- Roaming protocol
- iPhone and Android user applications
- iPhone and Android doctor applications
- Virologist Internal Panel

The managed solution uses European AWS data centres.

We also provide the open-source code and the support to deploy the infrastructure on servers owned by each country.

Each open-source component can be changed and adapted to different regulation or use cases that might differ from country to country.



Covid Community Alert

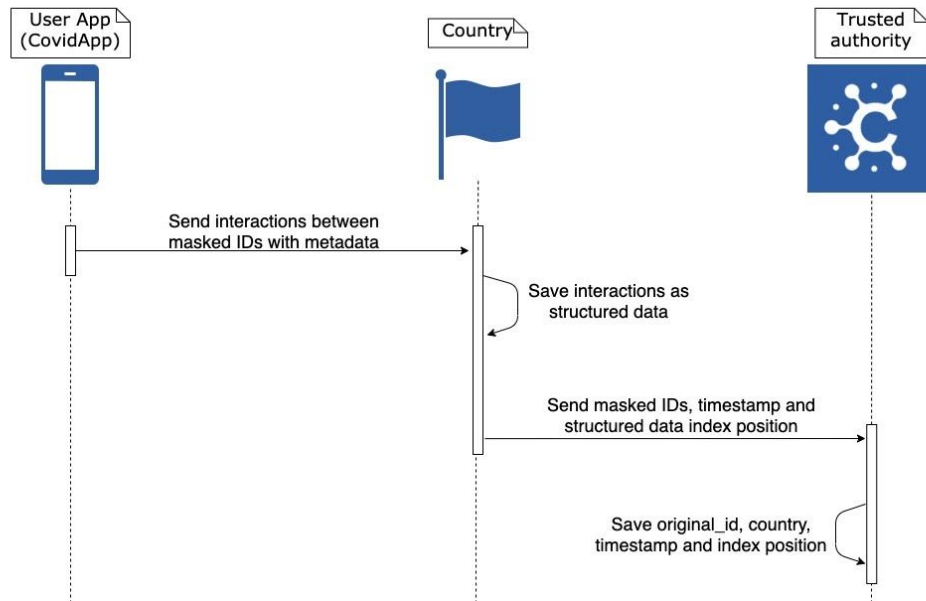
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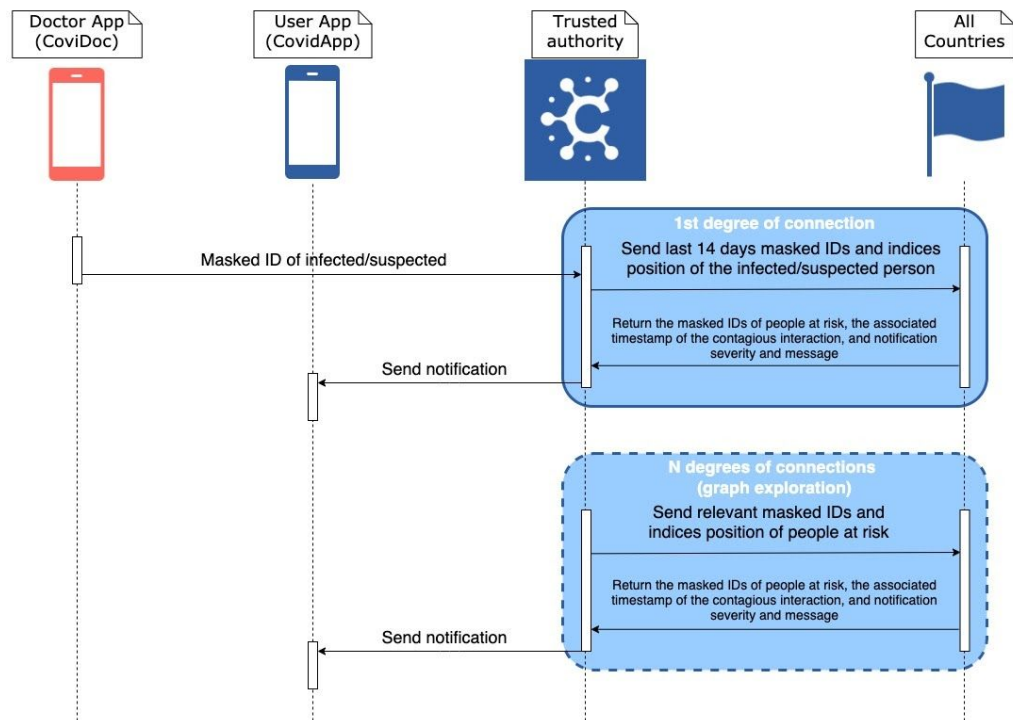
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Monitor anonymous interactions



Notify people at risk



Speed of reaction

We can automatically contact up to N degrees of connection of a positive diagnosed user. In addition, the notification can be sent directly from the laboratories where the swab is analyzed. Our platform also identifies patients who do not exhibit symptoms.

Optional soft-tracking GPS

Our users can decide to send GPS location information to our backend - still associated to their internal user ID and not to any sensitive or private data.

We only send GPS information to our backend if the user is receiving other Bluetooth signals, thus when he is not isolated.

If the user is instead isolated (home, walking, driving, etc...) we don't track them.

High accuracy asymptomatic patients detection

Thanks to the anonymous data we collect, we can infer the likelihood of a user to be asymptomatic.

We count how many times a customer has had interactions with positive patients. Based on his/her time and distance of exposure we can accurately detect if his probability of being infected is high. If this probability is high, it's likely that the user will either contract the virus or he/she already has it and he/she is asymptomatic. In both cases we suggest the user to self-quarantine.

Bluetooth signal cleaning process

Bluetooth signals are known to be very noisy.

Our mobile applications log surrounding Bluetooth signals every second and aggregate them every three minutes computing the median of all the values logged into this timeframe. This operation allows us to remove noise and have sufficient granular information to run interesting analysis on the exposure time.

Using the median over these three-minute slots we can detect if the users were close to each other without having outliers signals affecting the registered distance.

The distance measured by the RSSI (Received Signal Strength Indicator) of the Bluetooth signal is usually affected by a percentage error - the greater the distance the bigger the error. Under the 2 meters radius measured with Bluetooth signals post processed with filters or other aggregation functions do not differ much from the real distance.

Anyway, signals can be further cleaned by collecting what is the so-called RSSI-at-1-meter for each device. We decided not to explore this solution since the error of the measurements under 2 meters of distance is usually low.

We will ask the open source community to contribute with these measurements to reduce the residual error in the near future.

Virologist Internal Panel

We allow selected virologists from each country to define arbitrary levels of risk, based on the duration and the distance of the exposure with confirmed/suspected patients and other variables of

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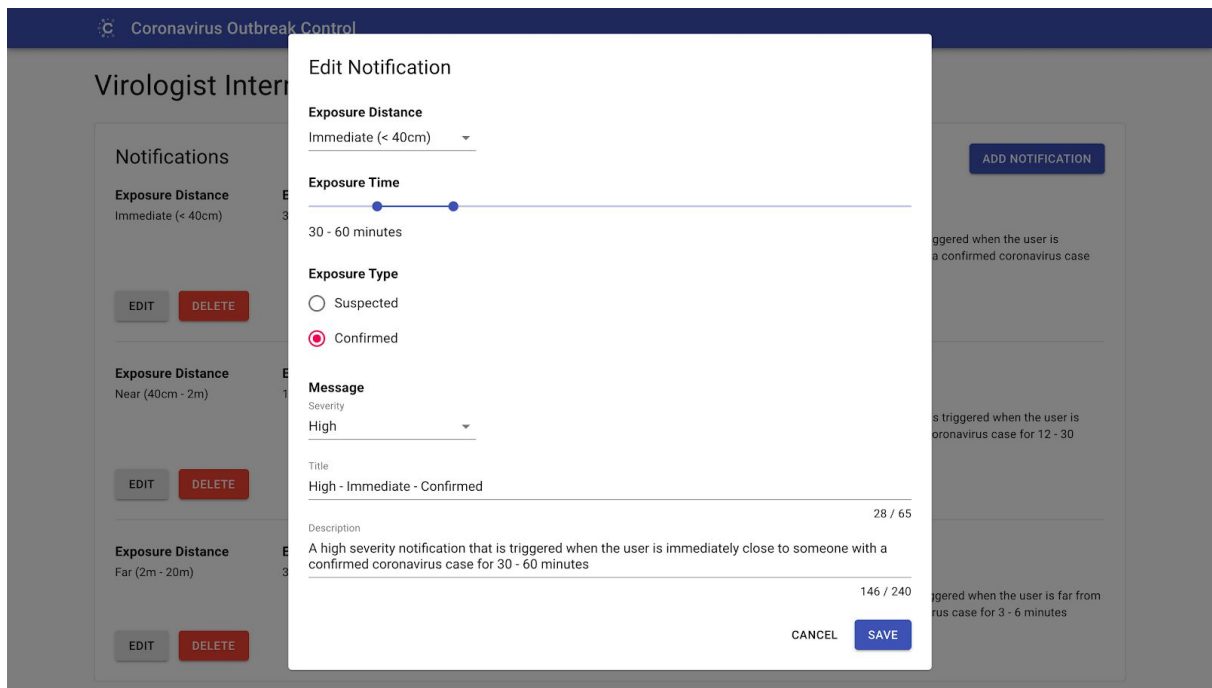
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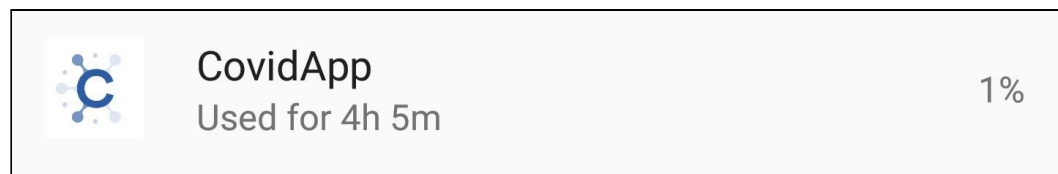
the person at risk, such as his/her daily interactions number.

This will allow us to anonymously notify people at risk with a tailored set of instructions. Moreover, we can identify people that might be identified as “hubs”, given their high number of daily interactions and advise them to self-quarantine to not put other people at risk.



Battery Usage

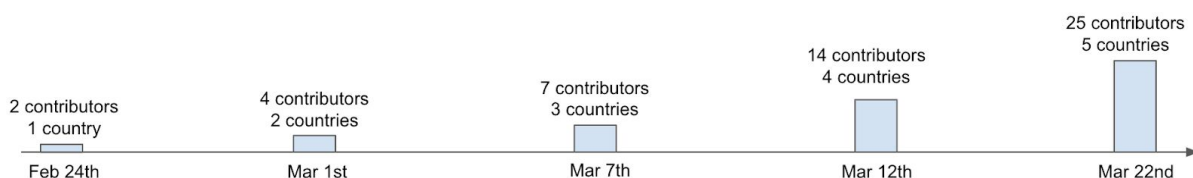
Tests showed that the application consumes 1% of battery every 4~8h on iOS and 1% of battery every 4h on Android.



Open Source

All the produced code necessary for the functioning of the service is open source and available online for review: [Coronavirus Outbreak Control](https://coronavirus-outbreak-control.github.io/web/index_en.html).

The team quickly expanded starting from 1 country and 1 founder up to 35 different active contributors from 6 different countries and three continents.



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We are receiving on a daily basis requests to contribute to our project.

Collaborating with research institutions

We are collaborating with the Head of the High Performance Computing Lab of CNR to optimise the detections of non Bluetooth-transmitting smartphones.

Our team in Brazil is adding to the open source project the possibility for the doctors to add details of the genetic information about the virus detected in the patients in order to study its evolution through time and its geographical spread, as well as how its genetic features affect different types of people.

The fully anonymised data collected can be used to get a better approximation of the real parameters that characterise the evolution and the spread of the virus.

Localisation

The user applications are currently localised in Italian, English and Portuguese to maximise its adoption. Moreover, we are currently planning to localize it in ten different languages.

The doctor applications are currently localised in Italian and English.

Anonymity and Security Protocol

Ensuring anonymity and being GDPR compliant is one of our priorities. No personal and sensitive data from the users are collected. The system relies on anonymised data, such as a randomly generated user IDs, the duration in seconds of the interaction, the distance in meters of the detected devices, the timestamp of the start of each interaction and the device operating system. No sensitive data are used to run any analysis. Covid Community Alert acts in accordance with European principles. The aim of the project is not to allow people to locate infected patients, but rather to give authorities the right tools to execute the best strategy to limit the outbreaks of the Coronavirus and potential future outbreaks, by allowing them to deploy solutions at scale.

Encryption and Security

All communications use HTTP over Transport Layer Security (HTTPS), an encrypted connection via asymmetric cryptography. The certificates are handled by Amazon AWS.

We don't save any mobile number, thus we don't store any sensitive or private information which can be reconducted to the user identity.

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Log Example

This is an example of the data sent from the device to the server via JSON protocol, using HTTP over Transport Layer Security (HTTPS), an encrypted connection via asymmetric cryptography. The certificates are handled by Amazon AWS. Below you can find its legend.

```
[{"i":1509,"o":1639,"w":1585780246,"t":17,"r":-70,"p":"a","d":"n",  
"s":1.57329,"x":51.489487,"y":0.0653553,"v":1}]
```

Legend:

i = my anonymous id

o = other anonymous id

w = start interaction timestamp

t = interaction duration in seconds

r = RSS

p = platform (a - Android, i - iPhone)

d = distance (i - immediate [<40 cm], n - near [40cm-2m], f - far [>2m])

s = distance in meters

x = latitude (optional)

y = longitude (optional)

v = log version

Comparison with other solutions

Particularly interesting is the comparison with TraceTogether and other European solutions that are based on the same approach (such as PEPP-PT):

- TraceTogether is an official app from the government of Singapore and they share their data with their Ministry of Health.
- TraceTogether is not Open Source (yet), we are.
- By design, TraceTogether saves the mobile number and the health status of users. Thus private and sensitive data are saved together. We don't save any mobile number.
- Given a mobile number, authorities could get the owner's identity as well as all the interactions he had in the past, jeopardising his privacy. We don't save any mobile number.

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- Technical studies show us that we can identify 37.4% more interactions worldwide - note that a linear reduction of R_0^3 has an exponential impact on the reduction of the spread of the virus.
- We allow selected virologists from each country to define arbitrary levels of risk, based on the duration and the distance of the exposure with confirmed/suspected patients. This will allow us to anonymously notify people at risk with a tailored set of instructions.
- With our infrastructure, we can also detect asymptomatic patients, hence notify them and invite them to quarantine.
- We plan to distribute SDKs to allow integration in other systems.
- TraceTogether cannot notify users who have been at risk, if the infected patient doesn't consent to it. Additional delays could depend also on the patient's situation: he/she could be sleeping or sick, his/her mobile could be offline or with low battery, and the emotional stress of the situation can play a role in the decision as well.
- Our fully automated system reduces the time in which patients at risk (and the potential infected network) get notified and eventually advised to self quarantine if necessary. The medical staff and/or virologists can send the notifications right after getting the test's result or the diagnosis has been made, saving precious hours to notify people at risk. Timing is crucial to reduce Covid-19 R_0 as demonstrated in the paper "Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing"⁴
- Our simpler login without mobile number check would potentially increase the app penetration.
- Our solution can retrieve people at risk up to n levels of connections with respect to the infected patient, and hence propagate the notifications to the specified network. Our solution is the only one in the market offering this feature.

Recent relevant news:

"Singapore to shut down workplaces and schools - contact tracing isn't effective enough. Prime minister says "despite our good contact tracing, for nearly half of these [new] cases, we do not know where or from whom the person caught the virus."

[\[https://www.straitstimes.com/singapore/health/most-workplaces-to-close-schools-will-move-to-full-home-based-learning-from-next\]](https://www.straitstimes.com/singapore/health/most-workplaces-to-close-schools-will-move-to-full-home-based-learning-from-next)

As our internal technical studies showed in the past weeks, we detect up to 37.4% more interactions thanks to our backend analysis worldwide and up to 52% in Singapore. A linear

³ https://en.wikipedia.org/wiki/Basic_reproduction_number

⁴ <https://science.sciencemag.org/content/early/2020/03/30/science.abb6936>

reduction of R_0 has an exponential impact on the reduction of the spread of the virus, due to a higher number of interactions.

From PM Lee statement we can infer that the TraceTogether Bluetooth solution was able to help the Healthcare system, but the interaction coverage that the app provided wasn't enough to stop the exponential spread of the virus.

Device of User	Surrounding devices	% of total interactions	Can the user's device detect surrounding devices?	
			Other solutions	Covid Community Alert
Android	Android	52.2%	Yes	Yes
Android	iPhone	19.5%	No	Yes
iPhone	Android	19.5%	Yes	Yes
iPhone	iPhone	7.3%	No	<ul style="list-style-type: none"> • No, if completely isolated. • Yes, if one or more Android are close to them.
Theoretical limit:		98.5%	71.7%	91.2% - 98.5%

We see this as a double validation of our solution: firstly, we can assume that Android interactions are correctly traced; secondly, considering that we could detect up to 52% additional interactions (iOS interactions) compared to those in Singapore and 37.4% worldwide, we would be able to counteract the virus spread with a higher effectiveness, because a linear reduction of R_0^5 has an exponential impact on the reduction of the spread of the virus.

⁵ https://en.wikipedia.org/wiki/Basic_reproduction_number

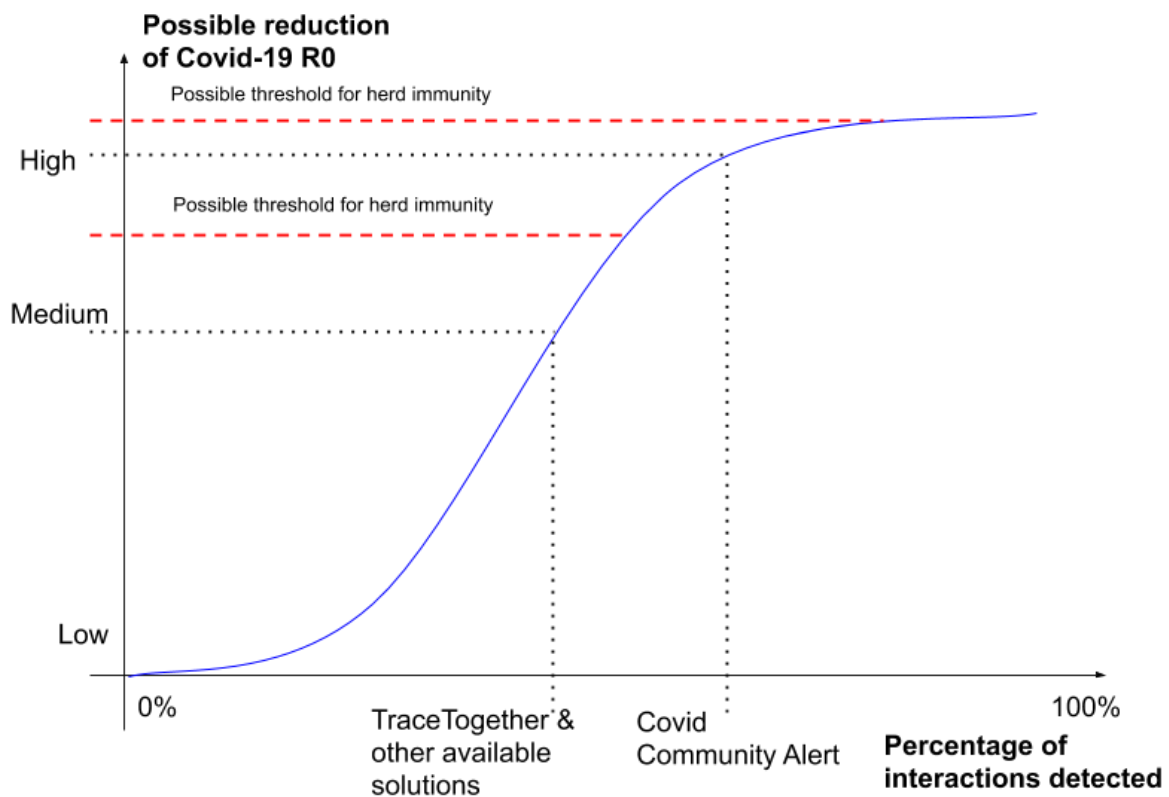
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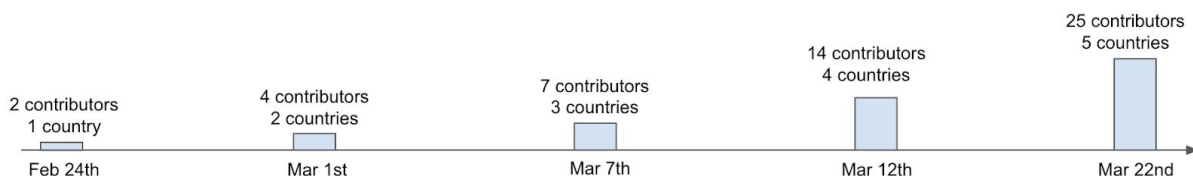


For more information please refer to the paragraph [Additional interactions detected](#)

About Us

All the produced code necessary for the functioning of the service is open source and available online for review: [Coronavirus Outbreak Control](#).

Our organization is called Coronavirus Outbreak Control Ltd. and the team quickly expanded starting from 1 country and 1 founder up to ~35 experts that are voluntarily contributing from 6 different countries and three continents.



We are receiving on a daily basis requests to contribute to our project.

The team has a multidisciplinary background: 10+ years of experience in distributed architectures and mission-critical software, founders and lead developers already worked together in the past building worldwide solutions for international partners, such as Airbnb, Google and Microsoft.

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Collaboration & Support

We are working with recognised Health Institutions and Research Centers

We collaborate with:

- Stefano Quintarelli: Mentor, Associazione Copernicani, Member of the AI High Level Expert Group at European Commission and Chairman of the steering Committee of Agenzia per l'Italia Digitale (AGID)
- Raffaele Perego, Director of Research, ISTI-CNR
- Vania Bogorny, Head of the Computer Science Graduate Program at Universidade Federal de Santa Catarina (UFSC) - Brazil

We are supported by:

- Stefano Fratepietro, Group Head of Cybersecurity - Chief Security Officer at Be Think, Solve, Execute S.p.A.
- Fabio Cassanelli & Emanuele Bartoli - Cyber Security specialists at Be Shaping the Future
- Marco Trombetti, founder at Pi-Campus
- Oreste Pollicino, Director of Bocconi LL.M. in Law of Internet Technology and full professor of Constitutional Law at Università Bocconi
- Stefano Leonardi, Full Professor at Sapienza University of Rome
- Sébastien Bratières, Director of AI, Translated
- Sebastian Filetti, STITCH (Sapienza information-based Technology InnovaTion Center for Health)
- Many more...

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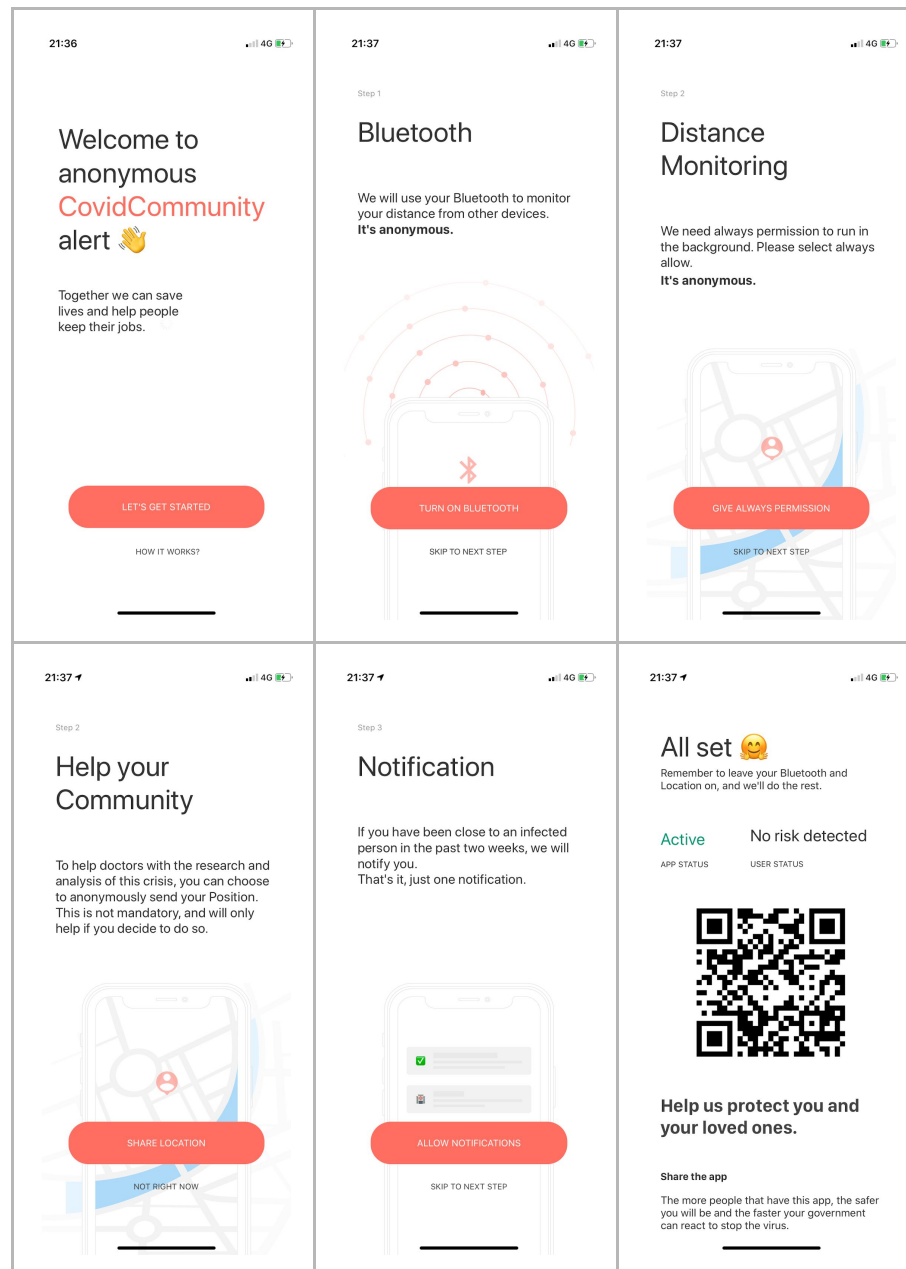
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Screenshots from the applications

User app - CovidApp



Covid Community Alert

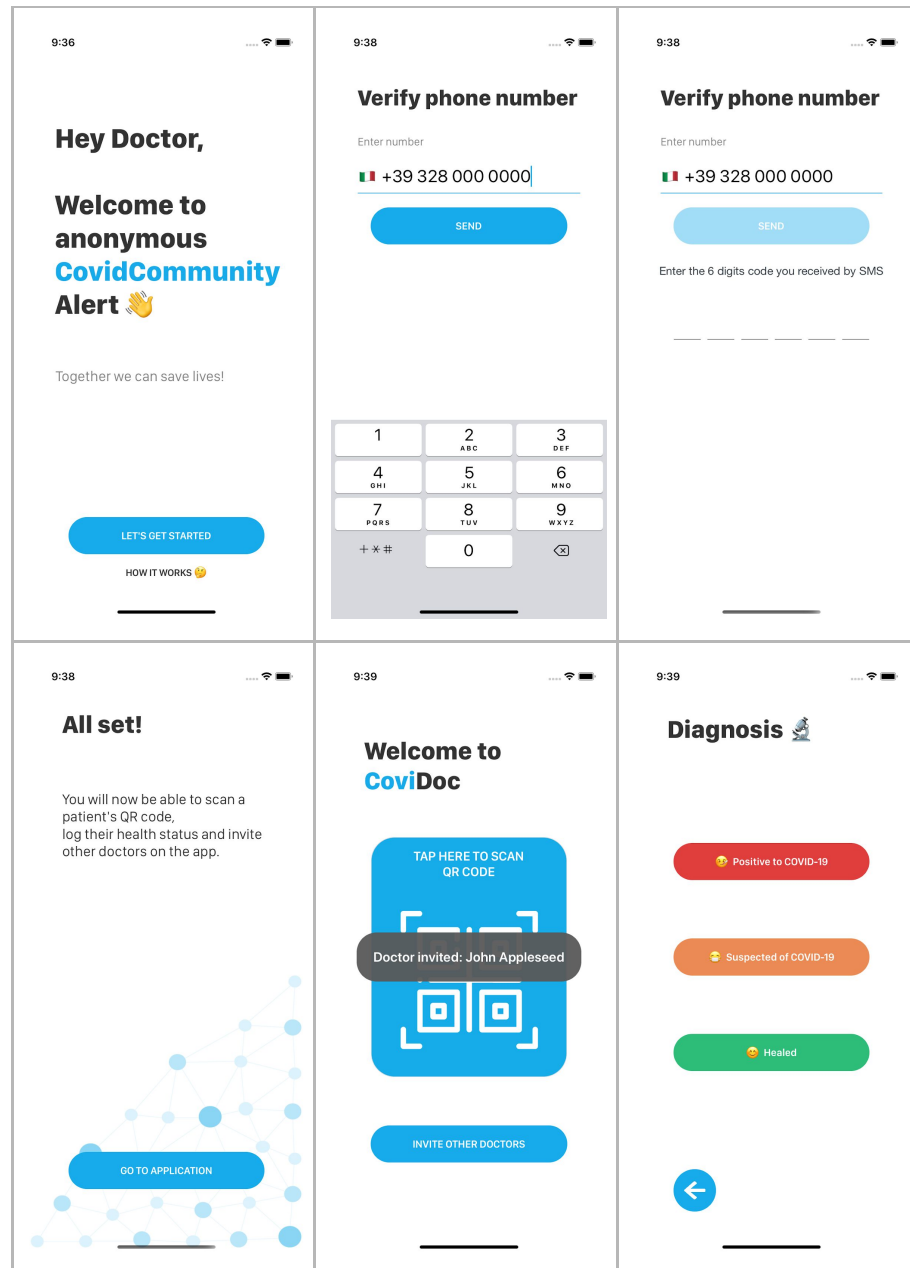
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Doctor app - CoviDoc



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Internal virologist dashboard

Coronavirus Outbreak Control

Virologist Internal Panel

Push Notifications

Exposure Distance	Exposure Time	Exposure Type	Message
Immediate (< 40cm)	30 - 60 minutes	Confirmed coronavirus case	High - Immediate - Confirmed A high severity notification that is triggered when the user is immediately close to someone with a confirmed coronavirus case for 30 - 60 minutes
Near (40cm - 2m)	12 - 30 minutes	Confirmed coronavirus case	Medium - Near - Confirmed A medium severity notification that is triggered when the user is near to someone with a confirmed coronavirus case for 12 - 30 minutes
Far (2m - 20m)	3 - 6 minutes	Suspected coronavirus case	Low - Far - Suspected A low severity notification that is triggered when the user is far from someone with a suspected coronavirus case for 3 - 6 minutes

Coronavirus Outbreak Control

Virologist Internal Panel

Notifications

Exposure Distance	Immediate (< 40cm)	30 - 60 minutes	Confirmed	High	A high severity notification that is triggered when the user is immediately close to someone with a confirmed coronavirus case for 30 - 60 minutes
Exposure Distance	Near (40cm - 2m)	12 - 30 minutes	Confirmed	Medium	A medium severity notification that is triggered when the user is near to someone with a confirmed coronavirus case for 12 - 30 minutes
Exposure Distance	Far (2m - 20m)	3 - 6 minutes	Suspected	Low	A low severity notification that is triggered when the user is far from someone with a suspected coronavirus case for 3 - 6 minutes

Edit Notification

Exposure Distance

Immediate (< 40cm)

Exposure Time

30 - 60 minutes

Exposure Type

☐ Suspected

☒ Confirmed

Message

Severity

High

Title

High - Immediate - Confirmed

Description

A high severity notification that is triggered when the user is immediately close to someone with a confirmed coronavirus case for 30 - 60 minutes

CANCEL

SAVE

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