Poster: Centralized vs. Decentralized Contact Tracing: Do GDP and Democracy Index Influence Privacy Choices?

Nina Tanaka, Gowri Ramachandran, and Bhaskar Krishnamachari
Viterbi School of Engineering, University of Southern California
Los Angeles, California, USA
{nstanaka,gsramach,bkrishna}@usc.edu

ABSTRACT

Contagious diseases such as COVID-19 spread rapidly, forcing governments and policymakers to employ corrective measures. Contact tracing is one of the critical tools to identify whether individuals came into contact with infected persons. Many countries, including Australia, Singapore, and India, have released contact tracing apps to reduce the community spread. Such apps follow either a centralized or decentralized architecture; the former lets government agencies store and manage the user's data without privacy support, while the latter allows the user more control over their information, providing privacy. We analyze how the GDP and the democracy index influence the adoption of contact tracing applications. Our study analyzes COVID-19 contact tracing projects announced between February 2020 and August 2020 from 63 countries. The data indicates that countries with high GDP and democracy index tend to opt for decentralized architectures, while autocratic and low GDP countries tend to adopt centralized architectures.

CCS CONCEPTS

• **Security and privacy → Social aspects of security and privacy**; **Economics of security and privacy**.

KEYWORDS

Contact Tracing, Privacy, COVID-19, Adoption

1 INTRODUCTION

Dating back to 1937, when it was first proposed by the then U.S. Surgeon General Thomas Parran in the context of Syphilis [4], contact tracing is an essential strategy used by public health professionals to control the spread of epidemics. Contact tracing is traditionally accomplished through interviewing people who have tested positive for the infectious virus, identifying close contacts of those infected patients, and reaching out to these contacts to warn them about their potential exposure and advise them on the next steps. This is important for epidemics because stopping the virus spread in its tracks through its carriers will help control and prevent future outbreaks.

With the advancement in technology, authorities have started to use mobile contact tracing applications for its benefits in scale-up and automate identifying who infectious persons may have come into contact with by using technologies such as GPS and Bluetooth on mobile devices [1]. However, while it offers such benefits, the use of these applications has also raised privacy concerns.

Contemporary contact tracing applications follow either a centralized or decentralized architecture [1, 7]. On the one hand, applications following centralized architecture provide less control to the user because it lets the government agencies collect and manage users' contact data. The decentralized contact tracing applications, on the other hand, allow the user to control which information to share with the central server and on what condition. Decentralized architectures are well-known for their privacy-friendly features, but it is unclear how the different countries select the architecture for their contact tracing applications.

Existing literature on contact tracing predominantly analyzed the importance of preserving privacy through decentralized architecture and cryptography primitives [1, 6, 7]. Moreno López *et al.* [3] examines how contact tracing adoption in different age groups impacts the effectiveness of digital contact tracing for the French population. Riemer *et al.* [5] argues that there are no acceptable policies and interventions to increase the global adoption of contact tracing, and they further show that governments around the world follow various strategies to increase the adoption of contact tracing. To the best of our knowledge, existing studies do not analyze whether the GDP and the democracy index influence the government's choices. Note that the architecture choice tends to determine the app's privacy level, which affects adoption.

In this investigative study, we analyze whether the country's economic status (i.e., GDP) and democracy index influence adoption. We have gathered information about GDP, democracy index, and contact tracing deployments for 63 countries through various governmental and online sources, including the Economist Intelligence Unit (EIU) and International Monetary Fund (IMF). Our investigation reveals that countries with high GDP and democracy index tend to favor decentralized architecture offering privacy guarantees. In contrast, autocratic and low GDP countries tend to prefer centralized architectures without preserving users' privacy.
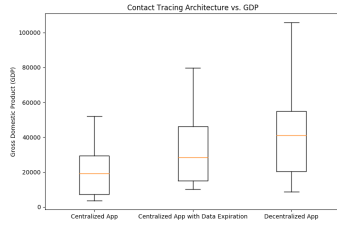
Figure 1: GDP tend to influence the level of privacy for mobile contact tracing apps.
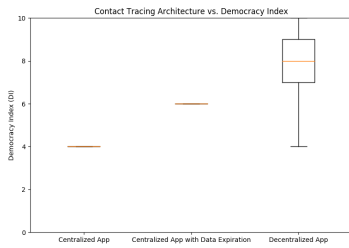

Figure 2: DI and its influence on privacy.

2 BACKGROUND

We will define the key terminologies in this section.

Gross Domestic Product (GDP): GDP is one of the vital economic indicators representing the total value of goods and services developed within a country, and it measures the country's financial health. The higher the GDP, the healthier the country's economy.

Democracy Index (DI): The Economist Intelligence Unit (EIU) measures the state of democracy and releases the democracy index. Higher DI indicates full democracy, wherein the governing policies follow the democratic principles, while lower DI denotes the autocratic or authoritarian government model.

3 METHODOLOGY

We have collected data about COVID-19 contact tracing apps from 63 countries using government websites and other online sources. For all these countries, we have gathered GDP and DI data from IMF and EIU websites, respectively. The open-source data is available at the following GitHub repository: https://github.com/ANRGUSC/gdp_and_di_analysisofcovid19contacttracingapps.

4 RESULTS

For our analysis, we have divided the contact tracing applications into three different categories based on their architecture, which are described below:

Centralized Apps: The contact tracing apps in this category collect location data and other personally identifiable information in a central server. The data is collected irrespective of the user's infection status.

Centralized Apps with Expiration: A few centralized apps collect user data, but they keep the data stored only for a short duration. Compared to Centralized Apps, this approach gives the

users confidence since the data would eventually get deleted from the central server.

Decentralized Apps: The apps in this category let the user keep the contact data locally on his/her mobile phone, and then share it with the central server only if the user is infected. Additionally, these apps even use privacy-preserving protocols that prevent the user from sharing any personally identifiable information to the central server [2, 6].

Note that we identified these categories based on information from websites, news and other articles about each project. As a somewhat subjective manual process relying on our interpretation of each project's documentation, which varied significantly in the amount of details presented, we acknowledge there may be some possibility of classification error in a small number of cases.

Figure 1 and Figure 2 show the analysis results. We list the important findings below:

- Higher GDP and democracy index (DI) is correlated with greater adoption of (more privacy-sensitive) decentralized apps.
- Countries with lower GDP tend to adopt centralized apps.
- Lower democracy index denotes that countries are leaning towards authoritarianism; it would appear that individual privacy concerns may be less emphasized in such countries.

5 CONCLUSION

Digital contact tracing involving mobile phones and wireless technologies has been introduced to understand and tackle the spread of infectious diseases such as COVID-19. Existing contact tracing apps either follow centralized (limited privacy) or decentralized (high privacy) architecture. In this study, we have analyzed contact tracing applications from 63 countries and shown that countries with higher GDP and democracy index tend to respect users' privacy by opting for privacy-preserving contact tracing technologies. In our future work, we will further analyze the effectiveness of contact tracing apps.

ACKNOWLEDGMENT

REFERENCES

[1] Nadeem Ahmed, Regio A Michelin, Wanli Xue, Sushmita Ruj, Robert Malaney, Salil S Kanhere, Aruna Seneviratne, Wen Hu, Helge Janicke, and Sanjay K Jha. 2020. A survey of covid-19 contact tracing apps. *IEEE Access* 8 (2020), 134577–134601.

[2] Arvin Hekmati, Gowri Ramachandran, and Bhaskar Krishnamachari. 2020. CONTAIN: privacy-oriented contact tracing protocols for epidemics. *arXiv preprint arXiv:2004.05251* (2020).

[3] Jesús A. Moreno López, Beatriz Arregui-Garćl̇a, Piotr Bentkowski, Livio Bioglio, Francesco Pinotti, Pierre-Yves Boëlle, Alain Barrat, Vittoria Colizza, and Chiara Poletto. 2020. Anatomy of digital contact tracing: role of age, transmission setting, adoption and case detection. *medRxiv* (2020).

[4] T Parran. 1937. Shadow on the Land: Syphilis New York. *NY: American Social Hygiene Association* (1937).

[5] Kai Riemer, Raffaele Ciriello, Sandra Peter, and Daniel Schlagwein. [n.d.]. Digital contact-tracing adoption in the COVID-19 pandemic: IT governance for collective action at the societal level. *European Journal of Information Systems* 0, 0 ([n. d.]).

[6] Carmela Troncoso, Mathias Payer, Jean-Pierre Hubaux, Marcel Salathé, James Larus, Edouard Bugnion, Wouter Lueks, Theresa Stadler, Apostolos Pyrgelis, Daniele Antonioli, et al. 2020. Decentralized privacy-preserving proximity tracing. *arXiv preprint arXiv:2005.12273* (2020).

[7] Serge Vaudenay. 2020. *Centralized or decentralized? the contact tracing dilemma*. Technical Report.