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Leveraging Wi-Fi Big Data Streams to Support COVID-19 Contact Tracing

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INTRODUCTION

The World Health Organization (WHO) announced the discovery of the new coronavirus: SARS-Cov2 or COVID-19, in January 2020. By March 2020, COVID-19 had spread worldwide and was declared a pandemic (Marinoni, van't Land, & Jensen, 2020). By April 2020, more than 3.4 billion people were in lockdown in around 80 countries worldwide. This represented a complete standstill of approximately 43% of the world's population. During the following months, COVID-19 continued to impose a new normal that has disrupted nations, industries, and businesses to an unprecedented level. The World Economic Forum declared that the pandemic had changed education forever (Li & Lalani, 2020). Higher education institutions' characteristics of vibrant campuses, where students experience an engaging, buzzing learning and cultural hub, experienced dramatic challenges (Times Higher Education [THE], n.d.). According to The United Nations Educational, Scientific and Cultural Organization (UNESCO), in April 2020, around 185 schools and higher education institutions closed their doors. The response of higher education institutions at the outset of the pandemic to rapidly adopt technology to maintain academic and operational continuity could be described as heroic, and it most certainly displayed a level of organizational agility that burst traditional stereotypes regarding educational organizations' ability to change. However, this shift to what is now generally recognized as "remote learning," while very impressive, has proven to be no replacement for the campus experience that so many students covet. Many learners had challenges with accessibility, inclusion, and engagement. A vivid reminder that the digital equity gap unfortunately persists—and has continued to widen—during the pandemic (Curtin, 2021).

Founded in 1919, The American University in Cairo (AUC) is an independent, not-for-profit, American-accredited, chartered institution of higher education and center of the intellectual, social, and cultural life of the Arab world. Its community of students, parents, faculty, staff, trustees, and alumni represents more than 60 countries. The University stands as a crossroads for the world's cultures and a vibrant forum for reasoned argument, spirited debate, and understanding across the diversity of languages, facilities, and human experiences (The American University in Cairo [AUC], n.d.).

The COVID-19 pandemic imposed new challenges to AUC's ability to maintain its standards of excellence in delivering on its mission of teaching and learning. Similar to other institutions in higher education worldwide, AUC took this as an opportunity to challenge its functions and work towards opera-

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tional excellence. In March 2020, AUC started preparing its faculty and students for online teaching then shifted its teaching and operations online effectively and efficiently before any higher education institution in Egypt. From the beginning, AUC focused its plans and decisions to overcome the pandemic around two guiding principles, capitalizing on its solid Digital Transformation resources. Those principles are:

1. **Health and Safety**: A commitment to prioritize the health and safety of students, faculty, staff, and the surrounding community in every decision.
2. **Deliver Quality Education**: A commitment to ensuring that the teaching, learning, and research of students, faculty, and postdoctoral fellows will continue at the highest levels of excellence.

In parallel, efforts to ensure the safe and healthy return of the AUC community were necessary. This chapter discusses how AUC leveraged its Wi-Fi infrastructure and Big Data technologies to offer a digital contact tracing solution that respects data privacy and ethics at an insignificant cost.

BACKGROUND

Since COVID-19 is highly transferable in indoor and closed locations, much research focuses on indoor tracking solutions. Indoor tracking systems vary depending on the type of signal used. The most common indoor positioning technologies are based on the radio frequency signals such as Wi-Fi, Bluetooth, and Ultra-Wideband (UWB). These solutions are usually composed of two elements: anchors and location Tags. Anchors are devices placed in the building, while a tag is carried by the person whose location is of interest. All of these technologies have their advantages and disadvantages. The main advantage of the Wi-Fi option is that it can use the pre-existing network infrastructure; Wi-Fi is available in mobile phones and other wearable devices. Thus, the Wi-Fi access point acts as an anchor, and the mobile device acts as a tag. This makes it easy to deploy and cheaper than other solutions requiring special anchors and tags. This advantage also could be applied to the Bluetooth option as Bluetooth is available in mobile phones. Both Wi-Fi and Bluetooth options calculate the distance based on the Received Signal Strength (RSS) principle. The strength of the signal is the main factor to determine the distance, which could lead to inaccuracy of around five meters as the signals vary enormously in the presence of obstacles and moving people. Different materials also affect the signals differently and consequently affect the accuracy of measuring the distance (Niemiller, 2019; Escobar, 2015).

The Singapore Ministry of Health implemented a solution based on the Bluetooth technology, 'Trace-Together'. TraceTogether is a mobile application for tracing and notifying people who came in contact with a Covid-19 case. The user should install the application on his mobile device, keep the app open in the background, and keep Bluetooth on. The other option is a token device for those who do not have a compatible mobile phone or the convenience of having the app on their mobile (Government of Singapore, 2020). The app logs all exchanges with nearby TraceTogether devices. Sometimes the Bluetooth signals could be exchanged through walls. So, when a confirmed case with COVID-19 uploads their Bluetooth proximity data to MOH, it is processed and filtered based on duration and signal strength to identify only the close contacts and notify them (Government of Singapore, 2020). The Bluetooth-based solution is convenient for indoor and outdoor tracing as there is no need for setting up any infrastructure such as Bluetooth beacons or location tags; mobile devices can play both roles. Furthermore, it handles the process of notifying people in contact with a positive case. The main drawback of this solution is that it