Prediction of Dengue Infected Areas Using A Novel Blockchain Based Crowdsourcing Framework

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Presentation Outline

- Introduction
- Motivation
- Background and Current States of the Problem
- Objectives
- Proposed Solution
- Implementation Details
- Results
- Future Directions

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Introduction

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Dengue

- Dengue -
  - A mosquito-borne viral infection.
  - The responsible virus is Dengue virus (DENV).
- *Ades Aegypti* is the carrier of Dengue virus. [1]
- Worst-ever outbreak due to
  - Poor urban planning
  - Concerned organizations' mismanagement
  - Resilience of some viral strands

1. Franklinos, Lydia HV, et al. "The effect of global change on mosquito-borne disease." *The Lancet Infectious Diseases* (2019).

Motivation

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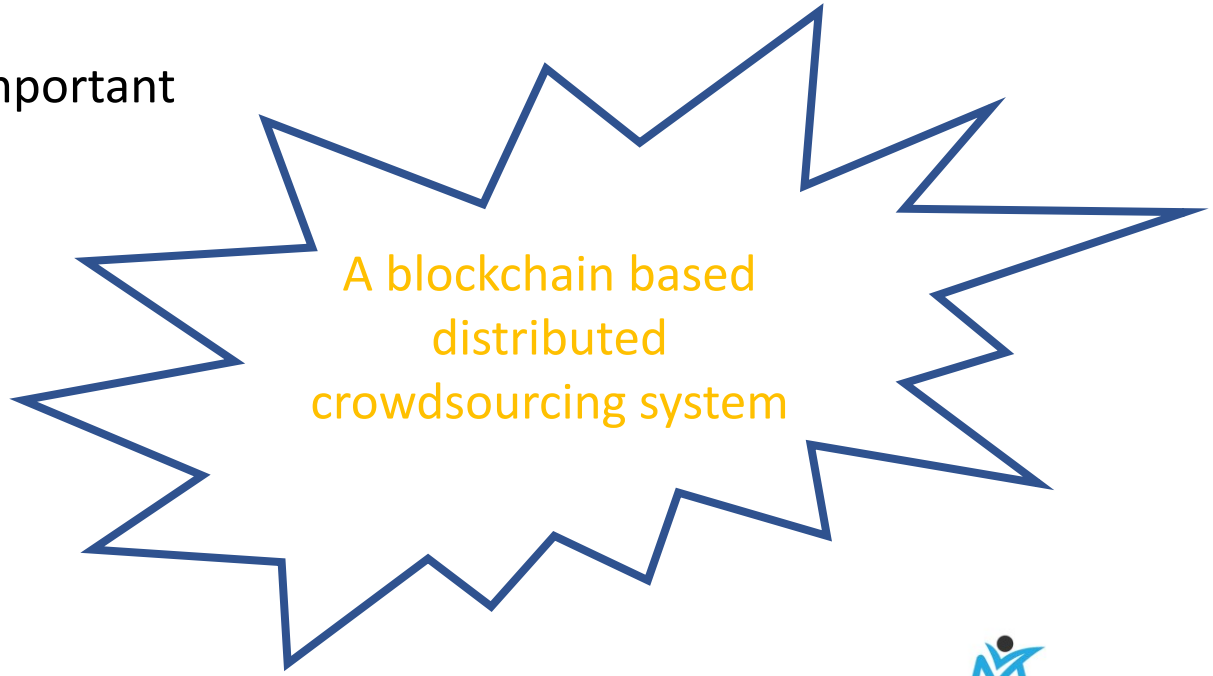
	Predominant vectors by genus	Estimated or reported number of cases per annum
Malaria	*Anopheles*	212 million (range 148–304 million)
Dengue	*Aedes*	96 million (range 67–136 million)
Lymphatic filariasis	*Aedes*, *Anopheles*, and *Culex*	38·5 million (range 31·3–46·7 million)
Chikungunya	*Aedes*, *Anopheles*, *Culex*, and *Mansonia*	693 000 (Americas)
Zika virus	*Aedes*	500 000 (Americas)
Yellow fever	*Aedes* and *Haemagogus*	130 000 (range 84 000–170 000) (Africa)
Japanese encephalitis	*Culex*	42 500 (range 35 000–50 000
West Nile fever	*Culex*	2588

Data are from WHO.[1,2]

Table 1: **Number of cases of the major mosquito-borne diseases of global health significance per year**

- Bangladesh has reached 98779 cases in 2019 as of 17 November 2019.[1]
- No appropriate way to
  - Identify the exact spots where these mosquitoes thrive
  - Identify the exact spots unless visiting the place in person

- Identification of dengue infected location is very important
  - To reduce its spread
  - To reduce the cost of spray medicine significantly.
  - To prevent unwanted death.



MOTIVATION

1. European Centre for Disease Prevention and Control. (2019). *Dengue worldwide overview*. [online] Available at: https://www.ecdc.europa.eu/en/dengue-monthly [Accessed 21 Dec. 2019].

Why Blockchain?

Why Crowdsourcing?

Background and Current State of the Problem

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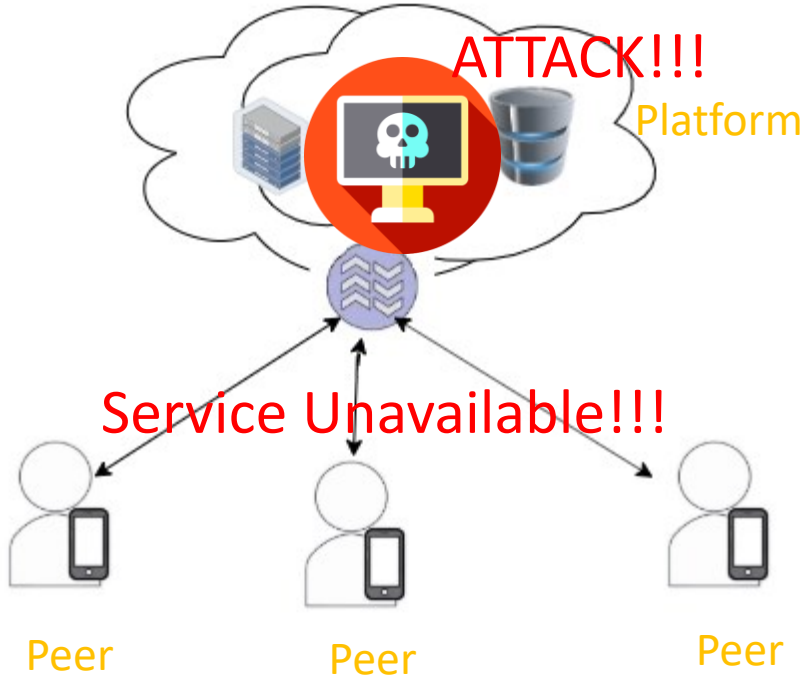
Centralized Crowdsourcing Platform

- Many crowdsourcing platforms have been developed by adopting a centralized architecture.
  - Upwork: Numerous projects are posted who seek to hire freelancers.
  - Amazon Mechanical Turk: Same approach as Upwork.
  - Waze Carpool: A navigation platform.

D. G. Kogias et al., “Toward a blockchain-enabled crowdsourcing platform,” *IT Professional*, vol. 21, no. 5, pp. 18–25, Jan. 2019

Problem with Centralized Solutions

- Single Point of Failure (SPOF) vulnerability.
  - with single point being the central authority



Elance experienced a DDoS attack in March 2014.[1]

According to Bloomberg, the hackers broke into Uber's private Github account and managed to steal data in October 2016.[2]

1. D. Meyer, “Elance and oDesk hit by major DDoS attacks, downing services for many freelancers,” Gigaom Technical Report, 18-Mar-2014. [Online]. Available: https://gigaom.com/2014/03/18/elance-hit-by-major-ddos-attack-downing-service-for-many-freelancers/. [Accessed: 11-Jan-2020].
2. Bloomberg.com. (2019). Bloomberg - Are you a robot?. [online] Available at: https://www.bloomberg.com/news/articles/2017-11-21/uber-concealed-cyberattack-that-exposed-57-million-people-s-data [Accessed 21 Dec. 2019].

Challenges for Decentralized Crowdsourcing Platform

- Prevent information tampering.
- Task offloading, along with handling.

Decentralized Crowdsourcing Platform

Xiaolong et al. (2019)

- A blockchain-based mobile crowdsourcing platform
- Salt down the privacy of the participants
- Keep the integrity of the service request and resources.

J. Park et al. (2018)

- A data evolution system for the efficacy of healthcare remedies.
- It is not biased by any parties or admin.

1. Xu, Xiaolong, et al. "A Blockchain-Powered Crowdsourcing Method with Privacy Preservation in Mobile Environment." *IEEE Transactions on Computational Social Systems* (2019).
2. J. Park, S. Park, K. Kim, and D. Lee, “CORUS: blockchain-based trustworthy evaluation system for efficacy of healthcare remedies,” 10th IEEE International Conference on Cloud Computing Technology and Science (CloudCom), Hilton Cyprus, Nicosia, Cyprus, December 10- 13, 2018.

Objectives with Specific Aim

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- Design and develop a distributed crowdsourcing system *to collect the possible infectious locations.*
- Deploy the system into *Ethereum-Blockchain* to make the system unbiased.
- To increase the accuracy of the system, data are collected from *the infected patients* and *the conscious citizen*.
- Two separate *heatmaps* can be generated with the data collected from *the infected patients* and *the conscious citizen,* respectively.
- To avoid fraudulent users, *two separate token generation* methods are used in the proposed system.

Proposed Solution

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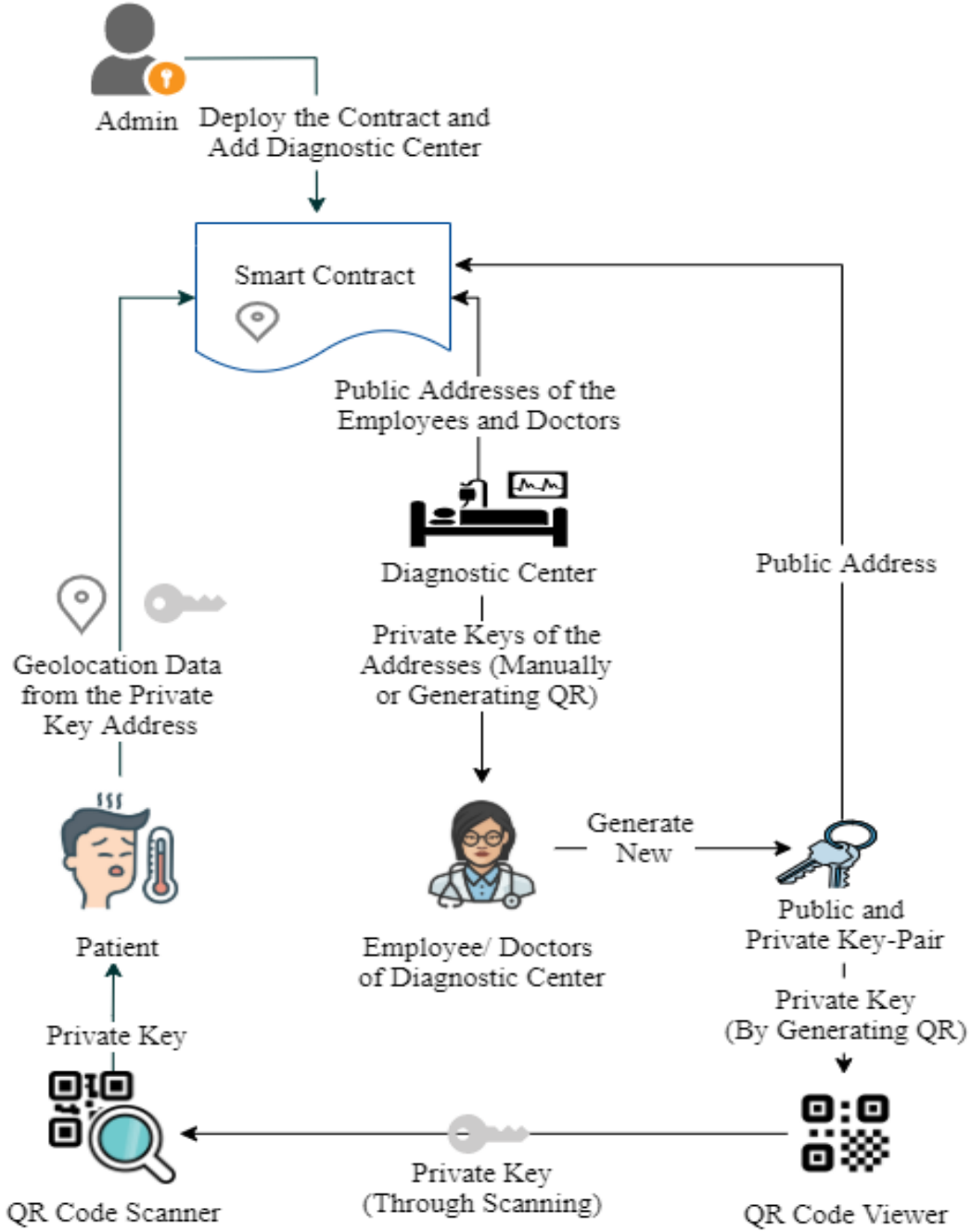
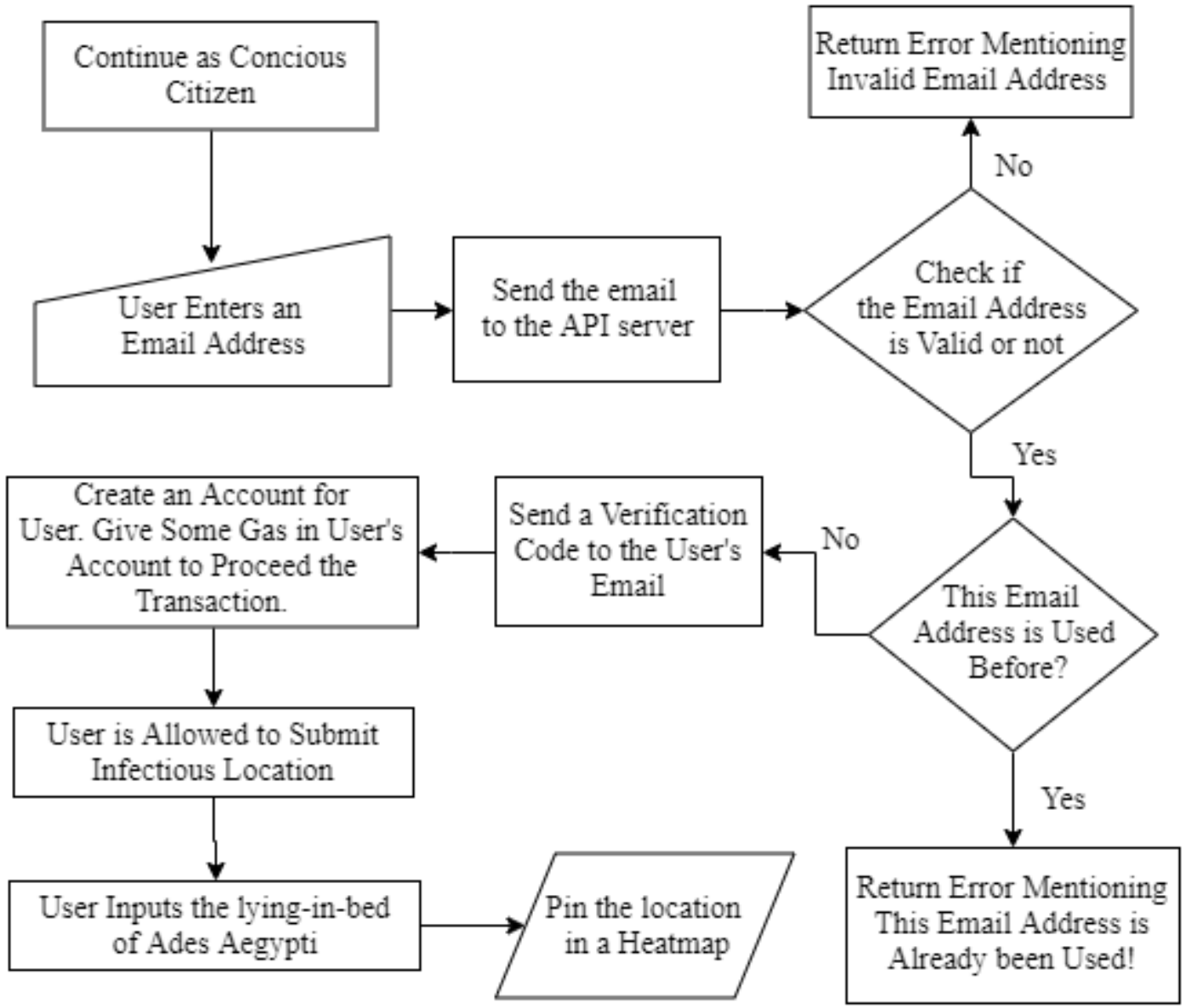
Stakeholders of the System

- Admin
- Diagnostic Centers
- Doctors and Employees
- Patients
- Conscious Citizen

System Model for Patient



System Model Conscious Citizen



Implementation

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Sub-Systems

- An Android application for users
- A website for displaying the heatmaps
- A webserver to validate email addresses provided by conscious citizens

The Backbone

Smart Contracts

Functions of smart contracts

- Add diagnostic center
- Add employees and doctors
- A function to generate login credentials
- A function to submit location data
- A function to generate heatmap

Algorithms for Patient's Data Submission

Algorithm 1 Add a patient by an employee

Require: Exisitng $Diagnostic\ Center\ id$ and $Employee\ id$
Require: $Patient's\ Address$ that will be added
Ensure: A new $patient$ is added to the $Patient'sList$
  return error if $Diagnostic\ Center$ is invalid
  return error if $Employee$ is invalid
  return error if $Employee's\ Address \neq Message\ Sender's\ Address$

  $patient \leftarrow new\ Employee()$
  $patient.address \leftarrow Patient's\ Address$
  $patient.enable \leftarrow true$
  $patient.createdAT \leftarrow now$
  store $patient$ to the $Patient'sList$
  $totalPatientCount++$

  transfer $WeiToSendUser$ amount of Wei to patient's address
  emit $PatientAddEvent$ event with $PatientAddress$ and $Index$ at which patient is added as data

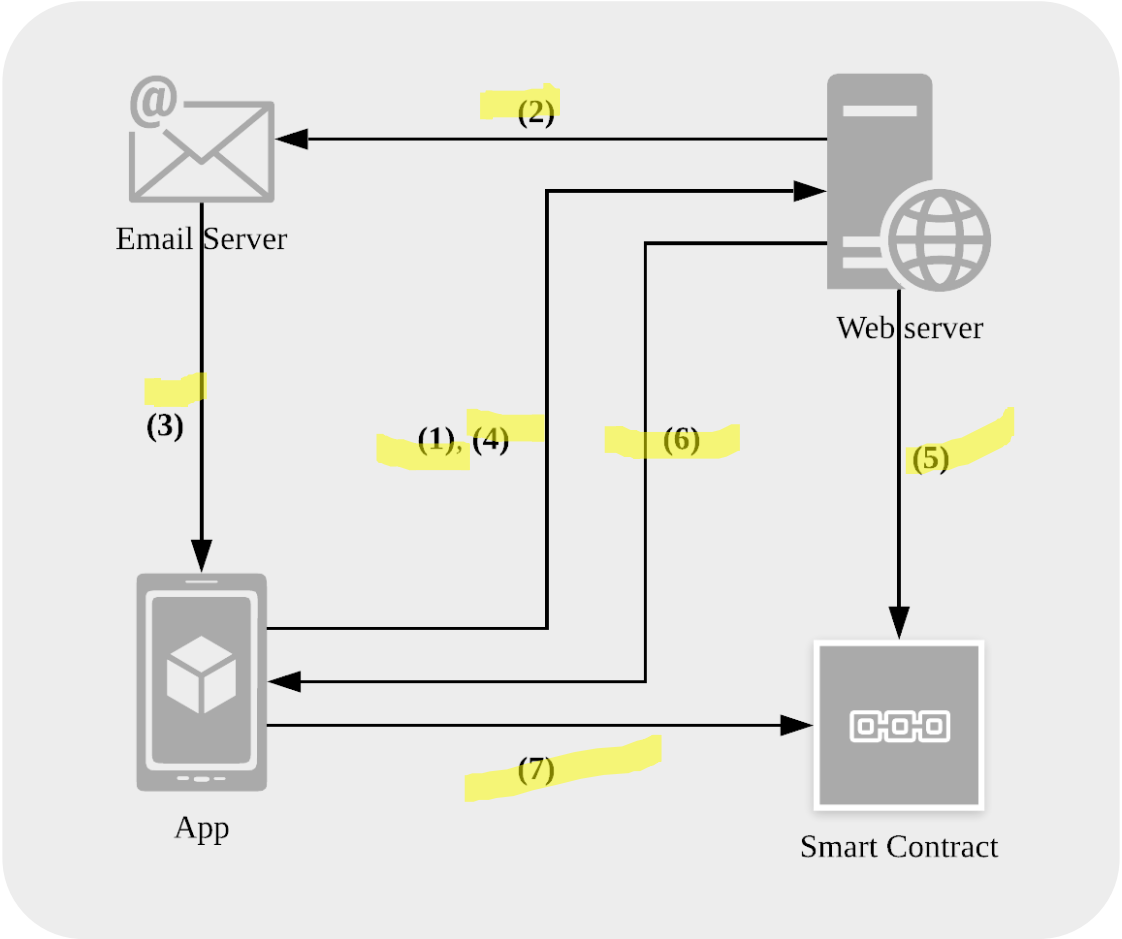
Algorithm 2 Submit location data by a patient

Require: Exisitng $Diagnostic\ Center\ id$ and $Employee\ id$
Require: $Patient's\ Location\ Data$
Ensure: $Patient's\ Location\ Data$ will be stored
  return error if $Diagnostic\ Center$ is invalid
  return error if $Employee$ is invalid
  return error if $Patient$ is invalid
  return error if $Patient's\ Address \neq Message\ Sender's\ Address$

  $patient \leftarrow getPatientFromStorage()$
  $patient.location \leftarrow Submitted\ Location$
  $patient.coordinate \leftarrow Submitted\ Coordinate$
  $patient.submittedAT \leftarrow now$
  save $patient$'s state

  emit $PatientSubmittedDataEvent$ event with $PatientAddress$ and $Index$ at which patient was loaded from as data

Conscious Citizen Data Submission



Results

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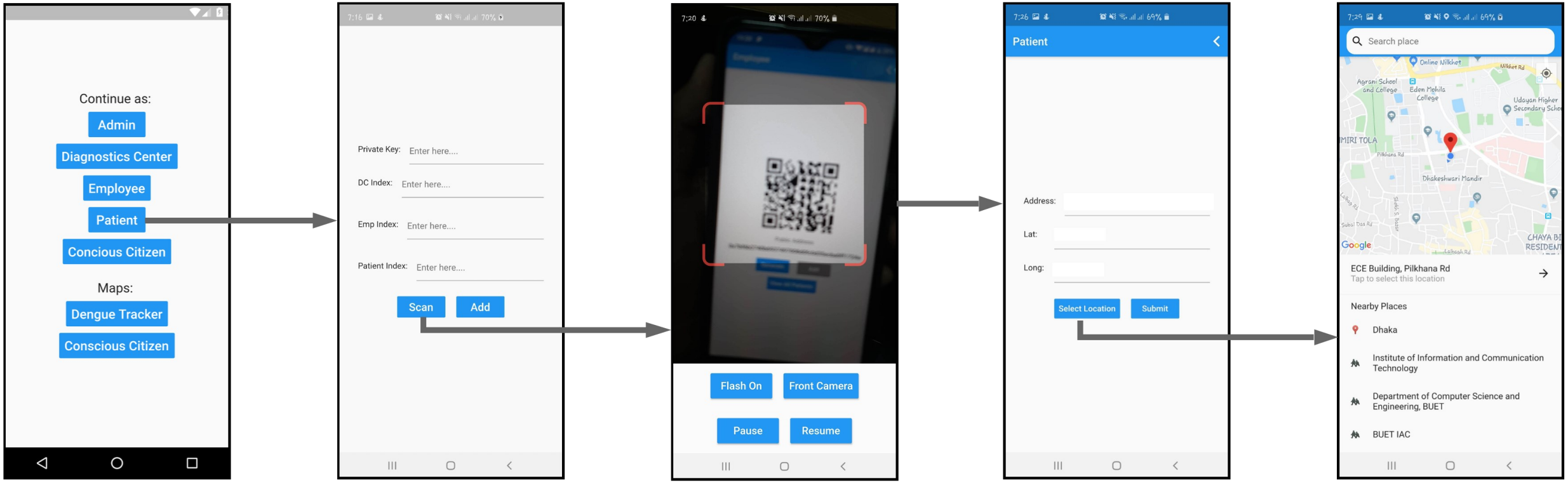
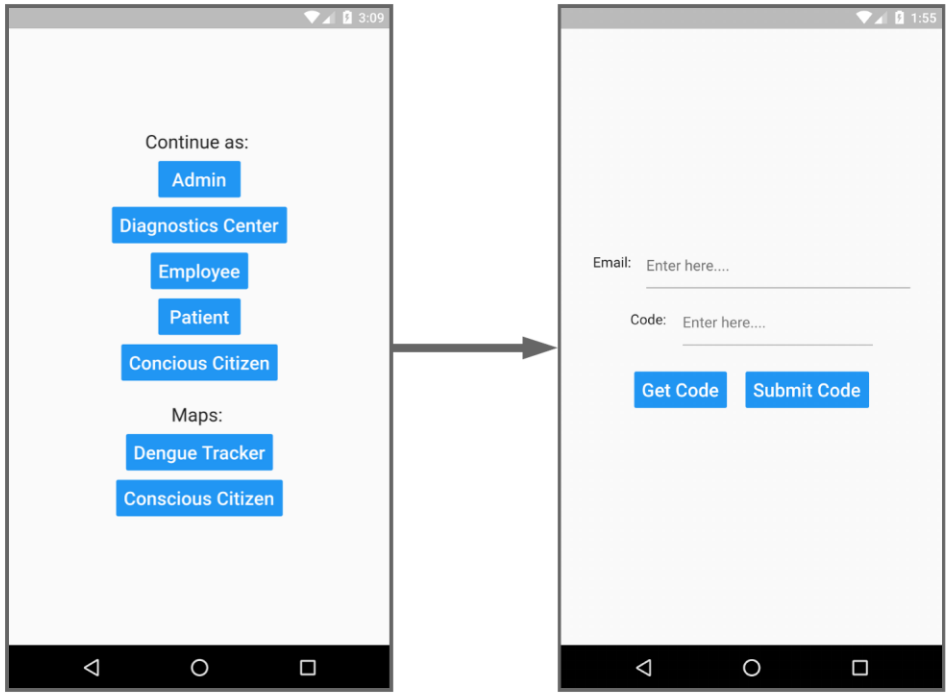
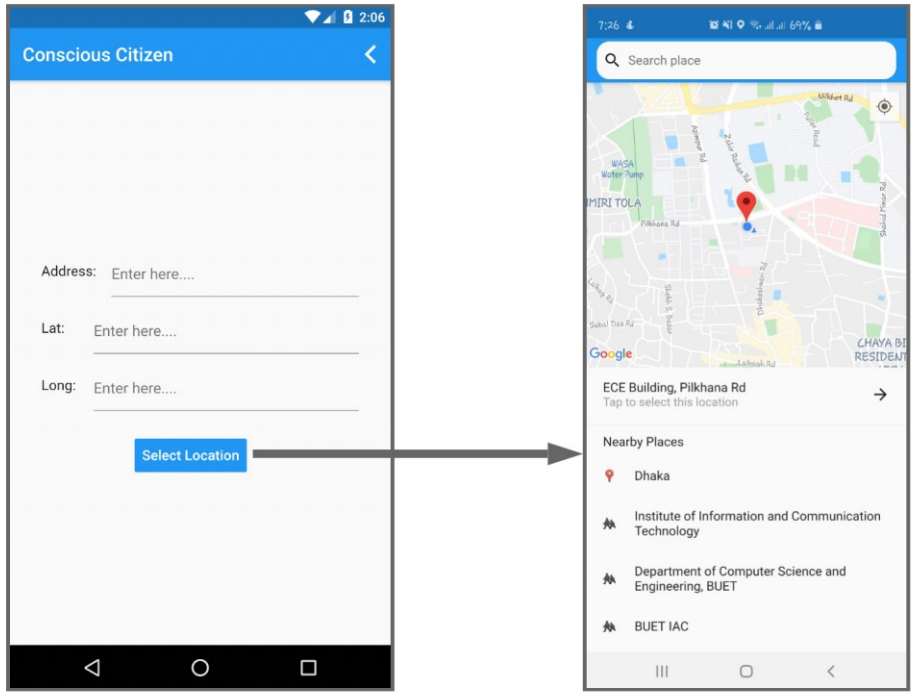
Patient Selects location from Map

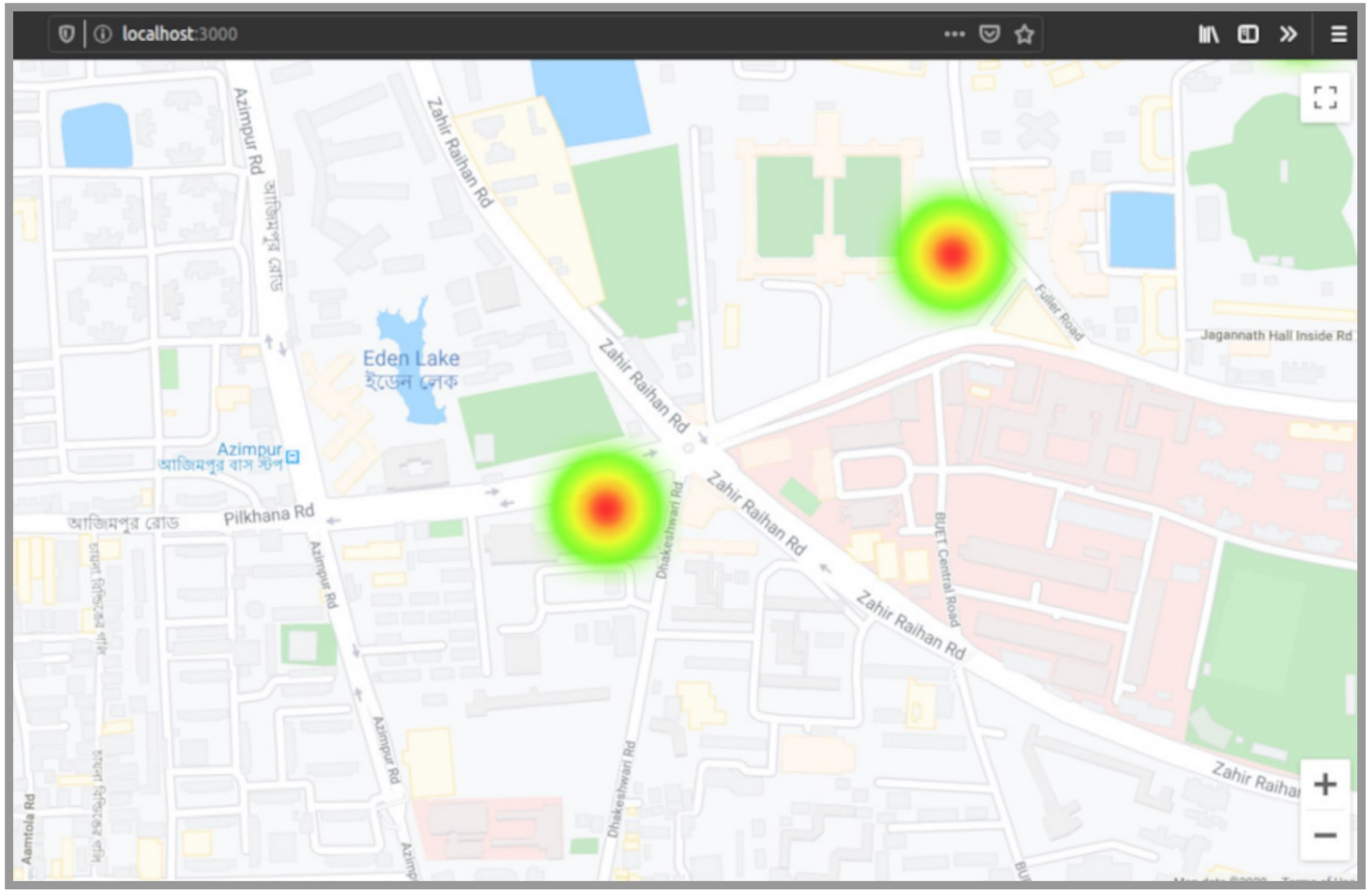


Conscious Citizen





Sample Heatmap Based on the Input of Conscious Citizen



Future Directions

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Future Directions

- We have implemented the PoC(Proof of Concept) of the Dengue Tracker system using public blockchain network. Try to design and implement the solution using private blockchain.

- Implement and expand the system for a different use cases like other COVID - 19.

- And try to implement the system by using On-chain random number generation, and solve the problem of disclosing the generated random number to all blocks on that network.

Thank You

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