Disaster Management Monitoring using Fog Computing in Internet Of Things (IoT) paradigm

ADITYA KUMAR B150476CS
ATUL SONI B150767CS
RAMANUJ KUMAR B150887CS
STAMI RAY B150709CS
SRUTHI P G B150254CS

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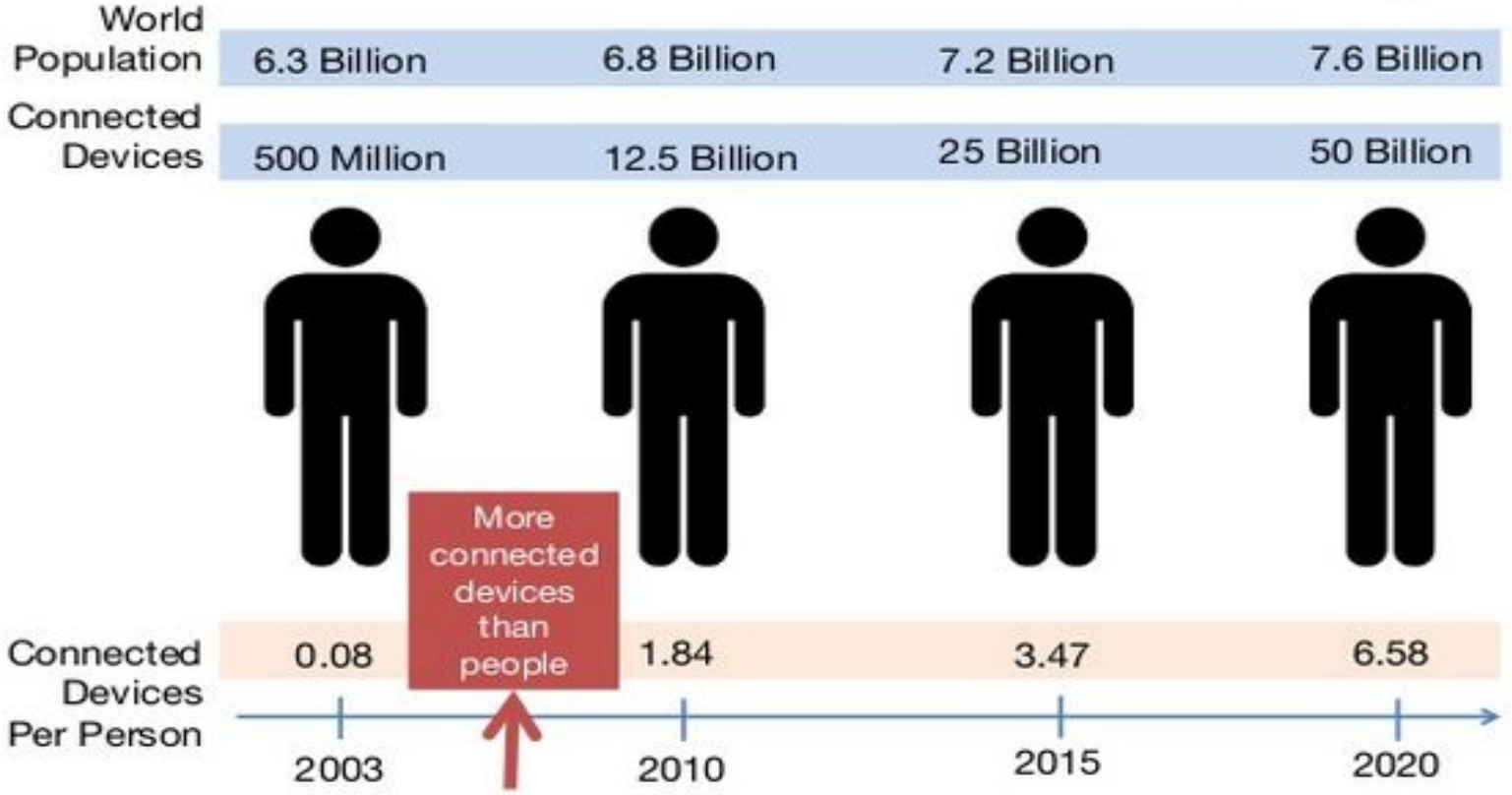
Index

Internet Of Things paradigm

The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity; which enables these objects to collect and exchange data.

More Connected Devices Than People



[Source: Cisco IBSG, April 2011]

Current applications of IoT

Nowadays, IoT systems are used to

- Smart buildings : Automatic temperature adjustment system
- Smart cities : Smart street lights, Information about free parking spots, Water leaking, CO2 levels

What is crowdsourcing in IoT?

In Internet Of Things paradigm, crowdsourcing is the process of obtaining and analyzing information or input to a particular task or project generated by a number of sources such as sensors, mobile devices, vehicles and humans.

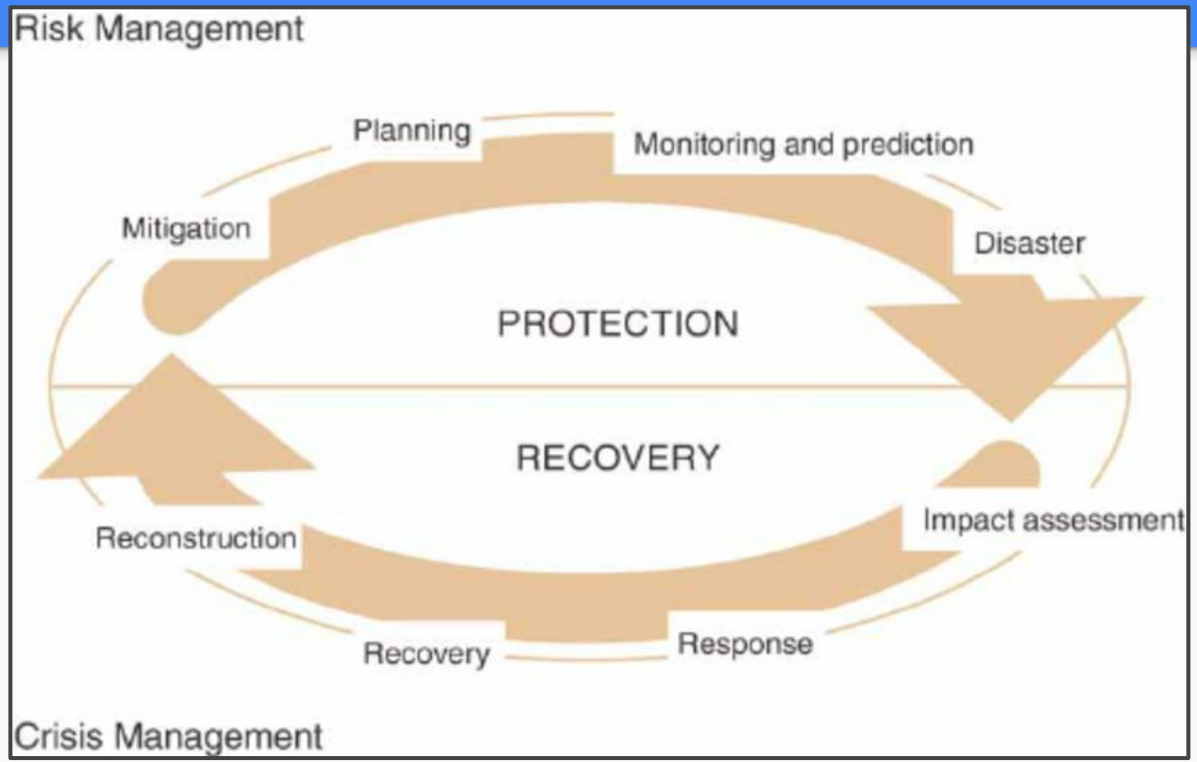
Examples Crowd-sourcing for IoT

- Examples of crowdsourcing based applications :

  (i) Amazon Mechanical Turk(AMT)

  (ii) The smart project: E-service for E-participation.

Disaster Management Monitoring



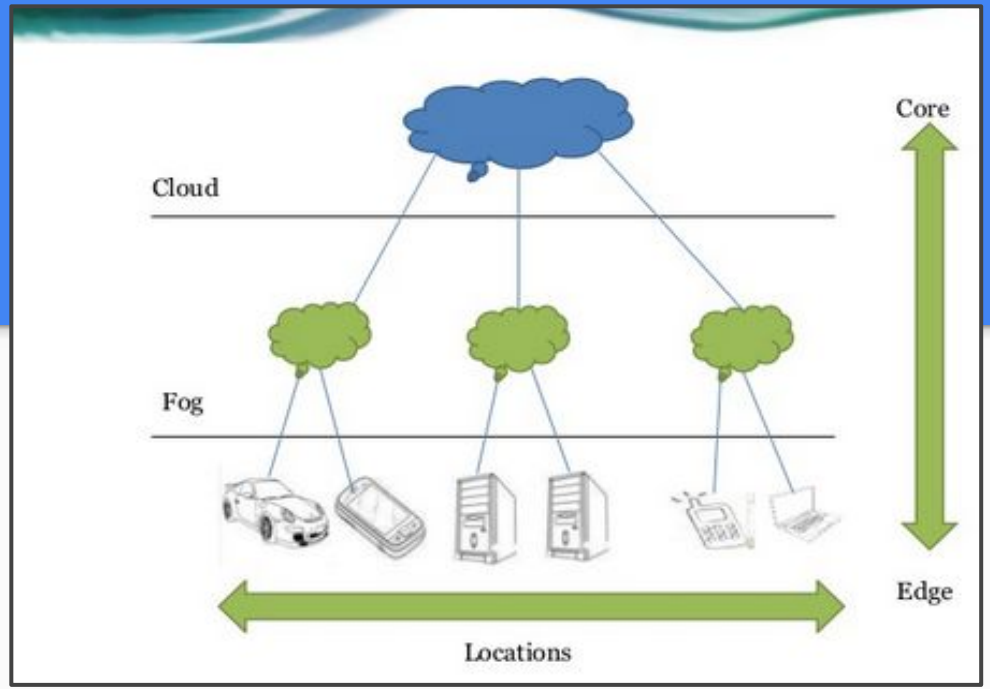
Disaster Management Monitoring Contd.

- Early detection of disasters such as earthquakes, fire, storms and floods
- Effective preventive measures, prediction and early warning systems can be made possible
- Thousands of lives and property can be saved

Process of Monitoring Disaster Management :

- remotely record and keep track of climatic aspects
- send notifications about climate changes
- send notifications about rescue operations

Fog Computing



- The term "Fog Computing" was introduced by the Cisco Systems
- Data, processing and applications are concentrated in devices at the network edge rather than existing almost entirely in the cloud.

Fog VS. Cloud

Requirement	Cloud Computing	Fog Computing
Latency	High	Low
Delay Jitter	High	Very Low
Location of Server Nodes	With in Internet	At the edge of local n/w
Distance between the client and server	Multiple Hops	One Hop
Security	Undefined	Can be Defined
Attack on data enrouter	High Probability	Very Less Probability
Location Awareness	No	Yes
Geographical Distribution	Centralized	Distributed
No. of server nodes	Few	Very Large
Support for Mobility	Limited	Supported
Real time interactions	Supported	Supported
Type of last mile connectivity	Leased line	Wireless

Fog Vs. Cloud

- Popularly, crowd sourced data of a particular geographic region is analyzed in a cloud platform
- But the latency in cloud computing platform is much higher than in a fog computing platform
- This delay in analysing the crowd sourced data in cloud computing makes early detection of disasters infeasible
- Real-time events such as disaster and natural calamities management need a better solution due to the delay and jitter caused due to the latency in cloud computing networks.

Fog Vs. Cloud Contd.

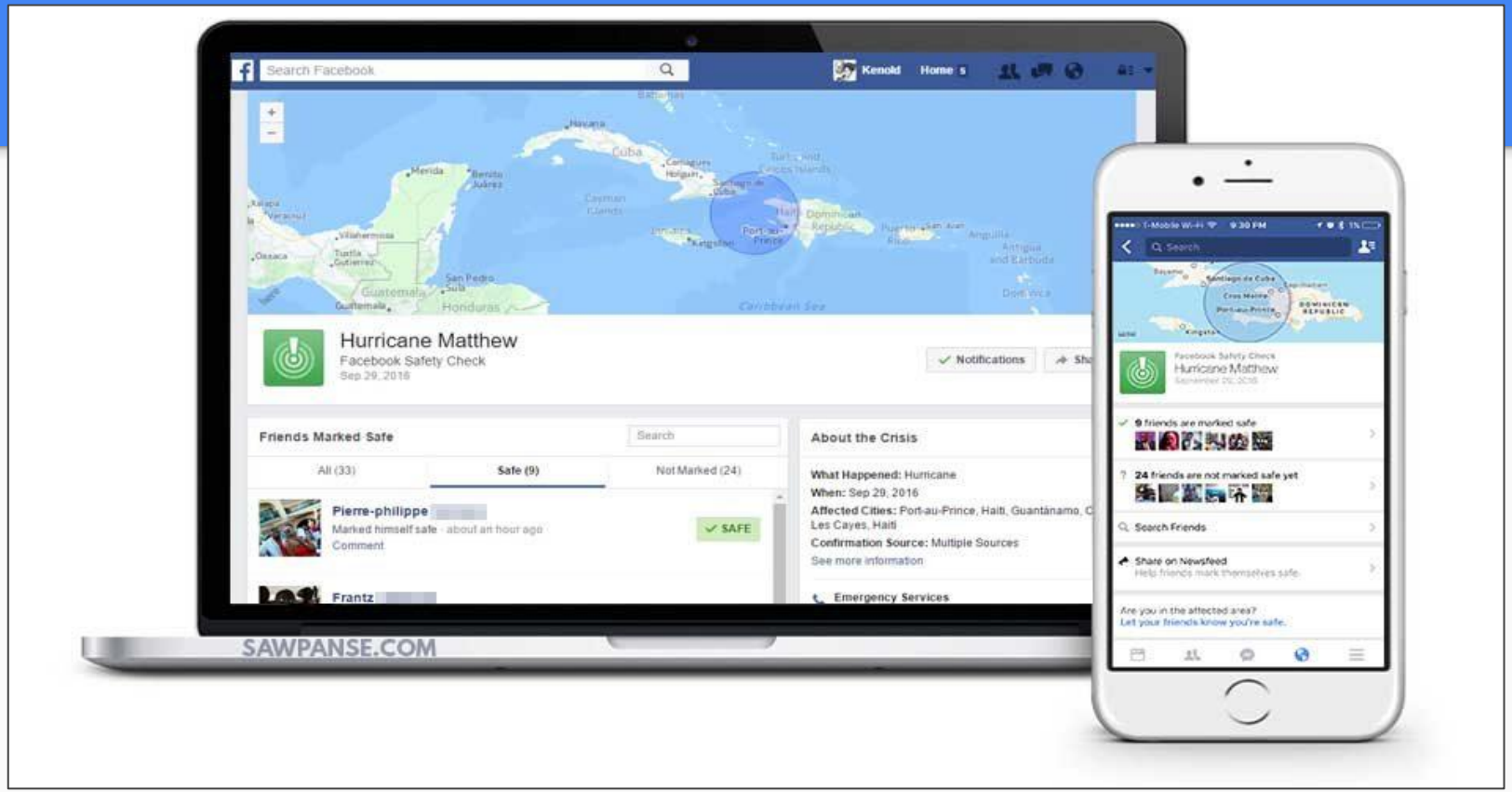
- Therefore, it is very imperative that fog computing/edge computing is employed
- In fog computing, such critical crowdsourced IoT data is analyzed at the network edge, close to where it is generated
- Only selected data is sent to the cloud for historical analysis and longer-term storage

Problem Statement :-

In this project, we aim to simulate a crowdsourcing-based disaster management monitoring system using fog computing (CDMFC) model in IoT paradigm for early disaster detection and preparedness [1].

In the paper ‘Crowdsourcing-based Disaster Management Using Fog Computing in Internet of Things Paradigm’, proposed by Rauniyar et al, an architecture for implementing CDFMC is studied upon.

Background and Related Works



Safety Check feature in Facebook.

- During an earthquake (7.8 on Richter scale) in Nepal, 25 April 2015,that killed over 8,000 people and left more than 21000 injured,Facebook came up with a feature called ‘Safety Check’ [7].
- This ‘Safety Check’ feature is based on the crowdsourcing model to disseminate the information as soon as possible so that effective rescue can be planned accordingly

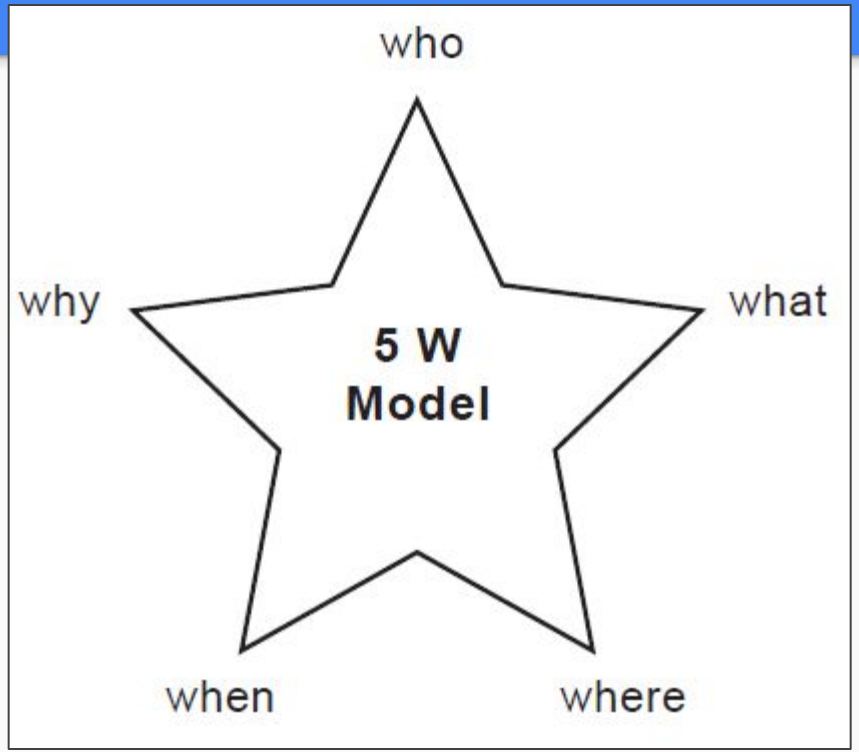
Safety Check feature (contd.)

- When activated, it locates Facebook users near a disaster site from where they used the Internet or through the city they listed on their profile.
- Facebook users are then asked to confirm whether they are safe or they are in disaster affected areas.
- Those Facebook users who choose option “safe”, generate a notification message to their family members, followers, and friends, who in turn can track how many of their friends/family members/followers were affected.

Emergency Micro message delivery using IoT

- During disasters, the conventional communication service is mostly interrupted.
- Vast deployment of IoT-enabled devices could bring benefits in terms of data network resilience.
- Emergency micro-message delivery communication service through data prioritization scheme can be enabled using IoT [2].

5W model



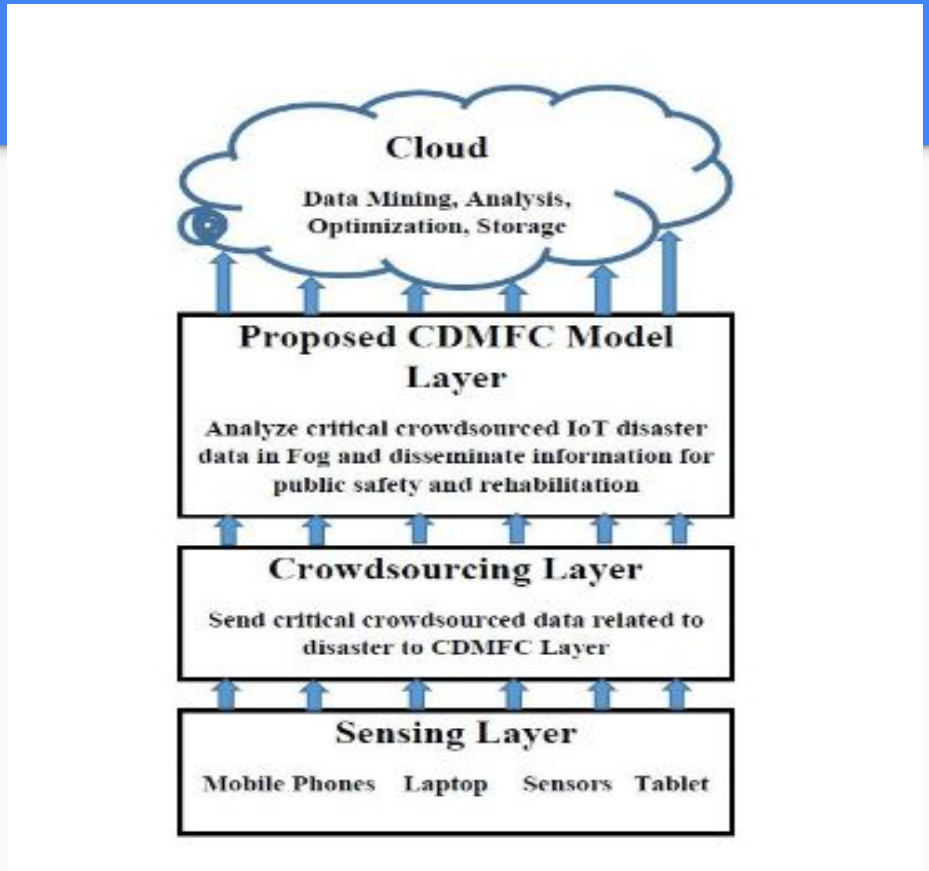
5W Model Contd.

- 5W (What, Where, When, Who and Why) model is based on social media big data.
- It has been proposed for managing urban emergency events.
- In 5W model, the users of social media have been set as the target of crowdsourcing.

Why we need fog computing???

- However, most of these schemes focus on cloud computing platform which has its own disadvantage in terms of delay.
- An efficient method to deliver time-critical sensing data successfully to the central authority or cloud during disaster situation considering poor communication infrastructure has not been invented so far.
- Network bandwidth is conserved as only disaster related data will be analyzed on fog and rest of the data will be analyzed in the cloud, in the case of fog computing.

Hierarchical layered structure of CDMFC model for disaster management



Layered approach to implementation

1. Event Sensing : Sensing layer (Layer I)

2. Crowdsourcing data : Crowd sourcing layer (Layer 2)

3. Sending Disaster related IoT Data to Fog/CDMFC Layer : Crowd sourcing layer (Layer 2)

4. Analyzing Disaster related IoT data in Fog : CDMFC layer (Layer 3)

5. Disseminating Early Information for Public Safety : CDMFC layer (Layer 3)

Layer- I : Sensing Layer

- Dedicated to sensing of different events such as fire, earthquake, flood, other natural and artificial disasters.
- Huge amounts of data will be generated due to sensing related to different IoT applications.
- Senses different events and generate sensing data irrespective of the type of events.

Layer - II : Crowdsourcing layer

- dedicated to crowdsourcing all the sensing data generated from the sensing layer.
- sends only disaster related emergency events data to the next layer, CDMFC layer.
- adopts filtering technique based on emergency and disaster-related keywords generated by the IoT applications and humans.

Layer III - CDMFC Layer

- The crowdsourced critical disaster-related IoT data is analyzed in CDMFC layer in a distributed way using fog computing in real-time.

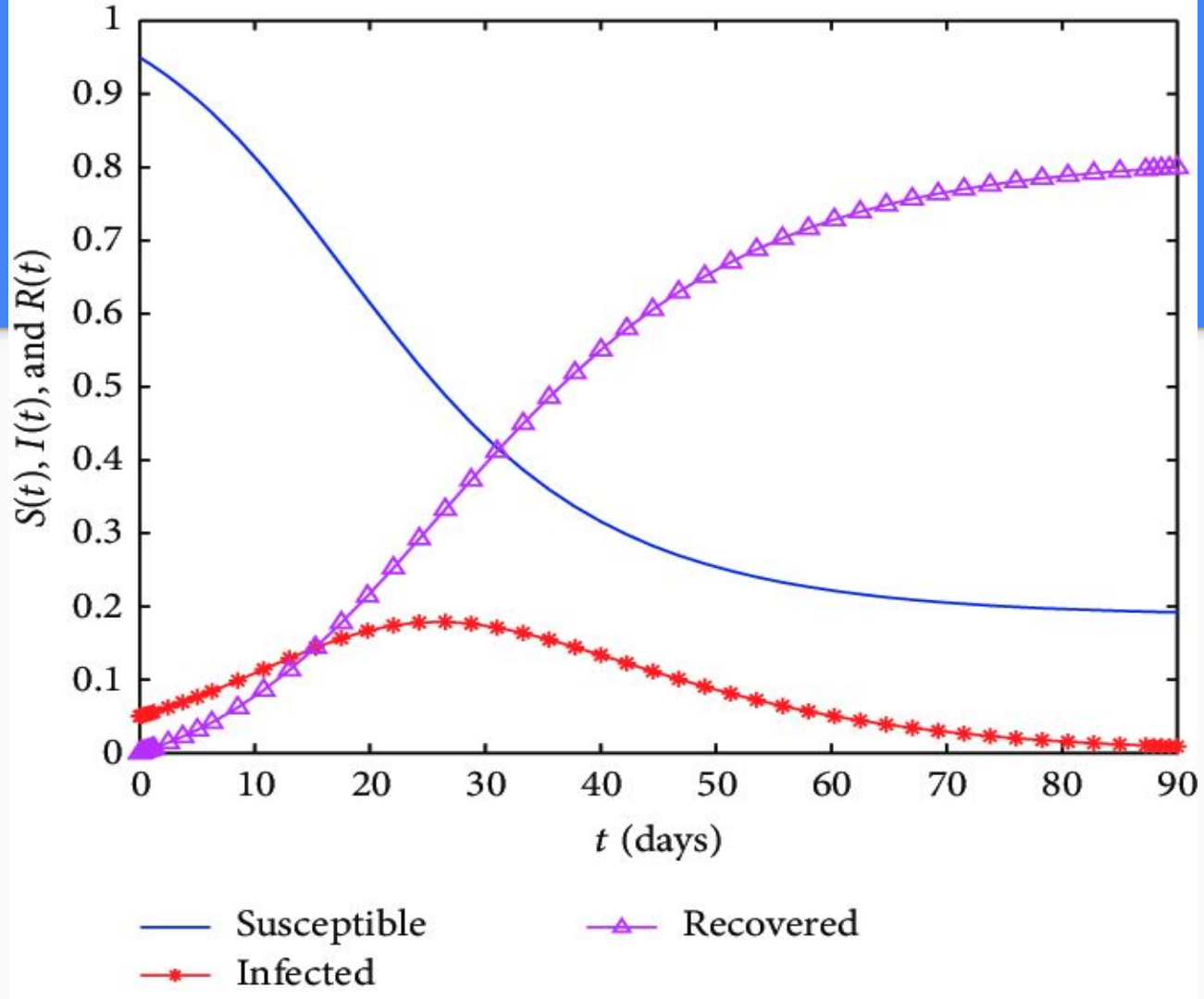
- This layer is equipped with emergency contact numbers and is directly accessible to public safety authority who can plan operations and take necessary action according to the crowdsourced critical disaster-related IoT data.

Layer - IV : Cloud Computing Layer

- The non-critical data from CDMFC model layer are analyzed and stored in the cloud computing layer.
- Extensive data mining and visualization techniques are applied to arrive at a concrete and final conclusion.
- Further, data are stored for a long time in the cloud for historical analysis.

SIR model (susceptible, infected and recovered)

- The **SIR model** is one of the simplest compartmental models.
- The model consists of three compartments– **S** for the number **s**usceptible, **I** for the number of **i**nfected, and **R** for the number **r**ecovered (or immune).
- These variables (**S**, **I**, and **R**) represent the number of people in each compartment at a particular time.


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
S(t), I(t), and R(t)
0
10
20
30
40
50
60
70
80
90
t (days)
Susceptible
Recovered
Infected

SIR Contd.

- SIR(susceptible, infected and recovered) model-based simulations can be used to investigate the extent to which the proposed CDMFC model helps in improving disaster prediction.
- The model is also helpful to compare the performance in different experimental scenarios.

Preliminary Implementation Details

- Architecture : Hierarchical Layered Architecture
- Language of implementation : Python
- Dataset : The ASEAN Disaster Information Network (ADInet)

Conclusion

1. To help public safety authorities plan out efficient rescue operations in the event of disasters, crowdsourcing the IoT data can be beneficial.
2. Analysing crowdsourced data in the cloud will incur latency issues and can hold up the rescue operations for disasters badly.
3. CDMFC model uses fog computing platform where the critical crowd-sourced IoT data related to disasters is analyzed in real-time

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THANK YOU !