Message Scheduling Delivery on Disaster Notification System

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Abstract

Natural disaster cannot be prevented, but its impacts can be eliminated or reduced. Mobile devices are the most effective and convenient communication tools which are not restricted by time and place. In this paper, the main service task is the timely delivery of possibly disaster information to mobile devices which are in the imminent disaster area. The system finds whether a mobile is within a defined disaster area using its GPS coordinates. The system architecture is built for sending notifications to mobile devices in disaster area. This system also proposes an algorithm for server side message scheduling based on queuing theory. This algorithm can handle queuing of messages and delivery to the target devices.

Keywords- *Android Notification Techniques, Location Based Service (LBS), Push Technology, Global Positioning System (GPS), Google Cloud Messaging (GCM), Circle Property*

1. Introduction

Everyone who is in IT field says "Today is the age of three things: Cloud Computing, Internet of Things, and Mobile." This word is true because there is no doubt that businesses can reap huge benefits from them.

In mobile technology, the traditional pull technology has become outdated because it requires that users know a priori where and when to look for data [6]. It suffers from transmission latency and duplicate data traffic. Then, a more accurate description of a process is appeared and it is called automated pull technology (push technology). However, all delivered information is wanted by users.

In this paper, push technology is used that allow the server to multicast the warning messages for imminent disasters according to the client regions. This system focuses on Android because it is used by majority of smartphone devices in the world.

The contribution of this paper is proposing message scheduling algorithm for handling and delivering messages.

The advantages of this system are the following. First, message can send to all without using operator. Second, it remains notification as a message and users can get it without missing any alert. Third, the system is mostly work on server that is reducing and managing the information overload as a result mobile users save battery life of phones.

2. Related Works

There are a number of papers that describe about timely disaster prevention. Disaster Management Center of The University of Wisconsin said the term Disaster management can be described as "The range of activities designed to maintain control over disaster and emergency situations and to provide a framework for helping at-risk persons to avoid or recover from the impact of the disaster"[10]. Most papers are focus on their nations. Some discuss not only prevention but also evacuation for mobile users.

Prof. Harish Barapatre, Ms shweta rane, Ms salma attar, Ms naina chaudhari made an application to help in the efficient provision of rescue and relief to disaster-affected areas [3]. This application is used for sending the location wherever disaster has taken place. It is also used by user who can provide help in affected areas. It works with two buttons, I NEED HELP and I WANT TO HELP. So this makes an interaction between the victim who is facing disaster and the volunteer who desire to help the victim. Lack of details on Google Map will be the main problem.

Saravana Kumar and Veeramani proposed their own algorithm "Extended Polygon Match Algorithm using Quadtree" to find whether a mobile is within a defined polygon shaped area using their GPS coordinates [7]. Their objectives are to build a prototype system using Android software to send alerts to mobile devices within the defined geographical area and to fix the search area and accurate location is easy using GPS. The advantage

of their system is that the disaster target region is perfectly contained. But the other regions also contain when taking the corner points of the polygon in map. They have planned to implement this concept in all the mobiles which is equipped with GPS.

Amit Gosavil, Vishnu proposed to notify the user located in possible disaster zone with visual and audio disaster warning and evacuation guideline combine with nearest location of shelter or safe zone on the map of the application [2]. This system helps out to both normal and blind people to reach to the nearest safe place prior to disaster. However, Lack of details on Google Map of developing countries is the main challenge of their work. They have to implement an application for rescue and relief operation with better server side application to totally automate the system of detecting disaster prone area as future work.

Yavuz Selim, Yilmaz Bahadir, Ismail Aydin Murat Demirbas evaluate arrival times to elaborate how GCM performs (timing performance of GCM), Poisson distribution to the number of devices per time, and conducted chi-squared goodness-of fit test on their models [9]. They point out GCM servers on client device does not by itself guarantee a timely message arrival. GCM is not a good fit for the applications where the broadcasting is mission critical, i.e. the message arrival to all client devices is vital, such as emergency alert services, fire alert systems, instant messaging apps, disaster alert services etc.

Harminder Singh, Dr Sudesh Kumar, Harpreet Kaur explain how GCM service and location service can be combined to develop a new kind of service [4]. They point out the message delivery using GCM is unpredictable, the devices may respond to user commands with different delay. The device must have stable internet connection.

The android notification systems usually use GCM. With that approach there was high risk of delay of data plus data unavailability. While GCM performs fairly well in online experiment, not all the devices receive the GCM messages in a timely manner. This paper overcomes this problem and its implementation steps are explained at proposed approach section.

3. Notification Technique

This section explains notification techniques for android push and Google Cloud Messaging. The worldwide smartphone market grew 13.0% year over year in 2015, with 341.5 million shipments. According to data from the International Data Corporation (IDC), android dominated the smartphone market with a share of 82.8% [5]. In Myanmar, android mobile penetration claims to reach 95% at the end of 2015 [12].

Android is used by the majority of smartphone devices in the world. It is popular because it is free and has an easy-to-use user interface. The Android operating system has received several updates since it was introduced in 2008 and it's currently at Version 5.0).

It has been estimated that 71% of all app developers in the world develop apps for the Android market, which keeps expanding daily.

3.1. Location based services

Location based services (LBS) are services offered through a mobile phone and take into account the device's geographical location.

LBS typically provide information or entertainment. LBS largely depend on the mobile user's location. These services can be classified into two types: Pull and Push. In a Pull type, the user has to actively request for information. In a Push type of service, the user receives information from the service provider without requesting it at that instant [13].

3.2. Push technology

Push technology is a style of Internet-based communication where the request for a given transaction is initiated by the publisher or central server. Push is also known as "Webcasting", "Netcasting" or "Pointcasting" [8]. Push notification is a kind of notification that has been sent out to a device by a central server. Push has more capacity than pull technology such as immediacy, efficiency, reduced latency, longer battery life, shorter learning curve.

Push notifications can be sent according to the services. For Windows Store app that use Windows Push Notification Service (WNS). IPhone and iPad apps are based on the Apple Push Notification Service (APNS). Push notifications to Android apps by using the Google Cloud Messaging (GCM) service [11]. To send push notifications to app, it needs to configure mobile service to work with WSN, APNS, and GCM. The general advantages using push technology are that the users no need to answer

questions when unsubscribing. The users have control over the flow of information. It does spam free and saves time. It brings notices and updates. In this system, it focuses on multicast-base push technology.

3.3. Google Cloud Messaging

Google Cloud Messaging (GCM) is used for sending message from cloud to android device. It is also a free service that allows developer to send data from third party servers to their applications running on android devices. It handles queuing of messages and delivery to the target application running on the target device. It supports Push Notifications and can payload up to 4 kb.

3.4. Global Positioning System

Global Positioning System (GPS) uses a constellation of between 24 and 32 earth orbit satellites that transmit precise radio signals, which allow GPS receivers to determine their current location, the time, and their velocity. GPS relies on a constellation of at least 24 satellites to provide location, speed and direction information to its users. It works by using a technique called trilateration combined with atomic clocks in the satellites in order to accurately determine the correct location [1].

A GPS receiver calculates its position by precisely timing the signals sent by the GPS satellites high above the Earth. It is self-calibrating so it just turns on and use. It can give bearings, directions. However, GPS technology is very power hungry and the GPS signal is unable to pass through solid structures so is unable to work indoors, underground, under the water, or under a dense canopy of trees.

4. Proposed Approach

This Paper are integrated by four major components: (1) defining disaster region for earthquake based on disaster types; (2) determining registered mobiles are in imminent disaster area or not; (3) An architecture used to send notification message the target mobiles in the defined region; (4) A proposed algorithm for message scheduling when the target device is not available (not connected to internet) the messages will be queued and will be delivered as soon as the device becomes available.

4.1. Marking Disaster Area

This module is used to mark targeted region in map, generate circle region for marked area. This system uses circle property that has the set of points in a plane that are a fixed distance from a given point, called the center.

For example, this system use region with circle mark when disaster earthquake become around two miles in a region. The following figure is marking disaster affected area and service area for registered mobiles.

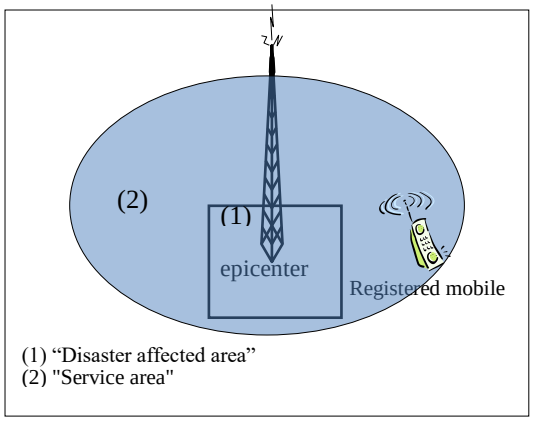

Figure 1. Marking Coverage Area by Circle

4.2. Determining registered mobiles’ area

The system determines whether registered mobiles are in service area or not so that this system compares distance between mobile device and epicenter with circle’s radius. If the radius of circle is greater than or equal to the distance, the mobile is inside the service area.

The following procedure is used to decide registered mobile region.

Algorithm: MbCircle (m_latitude, m_longitude, c_latitude, c_longitude, radius)

1. Initialization: mlatitude=mobile’s latitude; m_longitude=mobile’s longitude; c_latitude= epicenter’s latitude; c_longitude =epicenter’s longitude; radius=circle’s radius, d= distance between mobile device and epicenter;

2. $d = \sqrt{(c_{latitude} - m_{latitude}) * (c_{latitude} - m_{latitude}) + (c_{longitude} - m_{longitude}) * (c_{longitude} - m_{longitude})}$

3. if (d <= radius) then
4. print: Given point is inside the circle;
5. else
6. print: Given point is outside the circle;

4.3. System Architecture

Android application gets the current position through GPS from the user's mobile phone. Application registers to GCM that generates register ID. Then the application communicate with server not only register but also send the latitude and longitude of user's current position.

Then, the server send mobile's latitude and longitude to Google place API that is a service that provides information about places, spatial locations, and places of user's choice using user's requests. For registered users who are located in disaster area, the server sends message to GCM. Afterwards, application fetches the message from GCM. The architecture of the system is given in Figure 2.

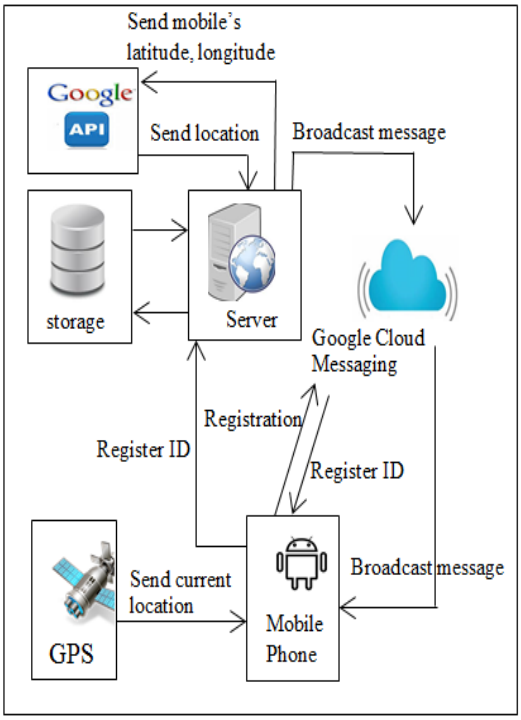

Figure 2.Communication between mobile phone, GCM and Server

4.4. Message Scheduling Algorithm

This paper proposes an algorithm based on queuing theory that will help as a temporary storage before sending notification messages from server to mobile devices.

Problem: some of the mobile connection still offline, the notifications will be queued, return notification message.

Inputs: A mobile id list L of positive numbers.

Algorithm: Message_Scheduling_Service

1. Initialization : mid= mobile id;
   Q = queue of mobile id;
   first = delete variable of mid from Q;
   last = insert variable of mid to Q;
   max = size of Q;
2. if a mobile is disaster region then
3. Q[last]=AddMid (first, last, Q, mid);
4. RelMid (first, last, Q, mid);

AddMid (first, last, Q, mid)

1. if first=null then
2. set first=1 and last=1;
3. else if last is equal to max then
4. set last=1;
5. else set last=last+1;
6. set Q[last] =mid;
7. end if

RelMid (first, last, Q, mid)

1. set mid=Q[first];
2. if (first=last) then
3. set first=0 and last=0;
4. else if first is equal to max then
5. set first=1;
6. else set first=first+1;
7. end if
8. end if

5. Operations

This algorithm uses First-In-First-Out (FIFO) system and redefines the existing normal queue. After a few operations the last might reach the end of the queue and no more devices can be added although the items from the first of the queue have been deleted and there is space in the queue. For this problem, both the last and the first indexes are taken to the beginning of the queue in algorithm. The implementation are explained the following Figure 3.

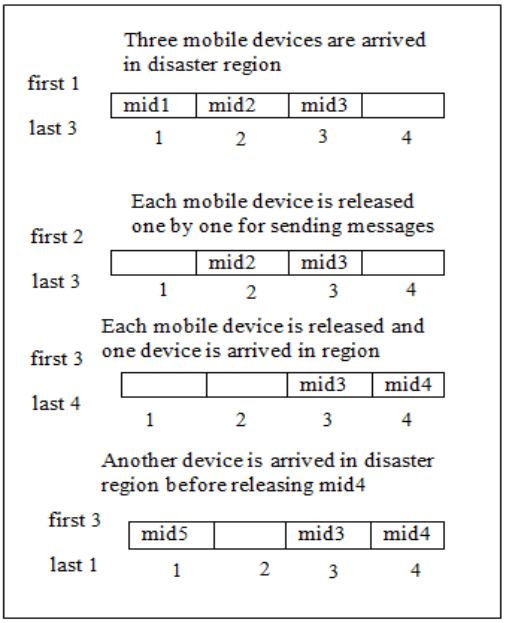

Figure 3. Allocation of Mobile devices using Message Scheduling Algorithm

6. Conclusion

This system is aimed by weather conditions that are too bad and facing difficulties. Notifications or alerts will be delivered to users who are in the disaster area (earthquake, cyclone). The notification is sent as timely delivery message from server. This system proposed message scheduled delivery service based on queuing theory. It supports to access message that retain the queue in server during offline.

This system has to do further research to define disaster region for cyclone. It needs to ensure batches of messaging operations are committed atomically that is data synchronization between client and server. Moreover, this system will do authentication that confirm the message is only sent by unadulterated server. This system will take not to be clients who receive the same message multiple times and not to message expire before being accepted during time-to-live period.

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