Vol. 9(34), Oct. 2019, PP. 4365-4382

Contents list available at IJMEC

International Journal of Mechatronics, Electrical and Computer Technology (IJMEC)

Journal Homepage: www.aeuso.org

PISSN: 2411-6173 - EISSN: 2305-0543

Designing Of An Energy Conservative Cloud Geo-Fencing Mobile Application For Schedule Reminder And Realtime Location Awareness

Alu M.D.[1], Ajayi O. O.[2] and Akingbesote A. O.[3]

[1,2,3]*Department of Computer Science, Faculty of Science, Adekunle Ajasin University*

Akungba-Akoko, Ondo State Nigeria

Phone Number: *+234-7056433798,+2348106746804*

****Corresponding Author's E-mail:*** *olusola.ajayi@aaua.edu.ng*

Abstract

The usage of mobile devices such as smartphones and tablets has increased dramatically over the past years. Most of people carry at least one mobile device wherever they go. Mobile devices are becoming really important nowadays because they are usually the main tool for communications. The dispersion of mobile devices across the world brought about the applications of geo-locational system in these mobile devices. However, the consumption of energy increases, even as innovations increases in geo-location for mobile development system[5]. The problem occurs because, users will continue to change state and while doing so, location's request will also be continually made, and the current geo-locational systems applications in mobile devices makes request based on either passive, wifi or using cell tower techniques. To address the problem, this paper presents a novel concept of energy conservation in geo-locational system for mobile devices. This concept gives an optimized way to make location request using fuse provider API techniques. This technique is in such a way that, other request made by several geo-locational apps on a device, can be fetched by this fuse provider technique oriented system and by so doing, the frequently energy consumption as a result of location request can be reduced. Therefore, in this research, I will design a location-based personal schedule reminder for Android-based smartphones and tablets and apply the same fuse provider API technique.

Keywords: *geo-locational system, fuse provider technique, mobile application, location request, energy/power conservation, geo-fencing.*

1. Introduction

Mobile device is usually defined as a small handheld computing device that has a main purpose of providing communication function over wireless networks. Two of the most popular mobile devices are smartphones and tablets. Mobile devices usage has increased substantially over the past years. The statistics shows that at the end of 2013, global smartphone penetration has reached 22% of world population where there are estimated 1.4 billion smartphones in use [1]. As this Mobile devices increases, then the chances for increase in mobile technology crawl in. According to [2] we can say that wireless phone standards have a life of their own since they are spoken of reverently in terms of generations. The ancient stone-age sounding 1G, or analog cellular, then like 80‟s rock came 2G, or digital cellular; 3G wireless, 4G, 5G and so on. The last decade stood witness to remarkable burgeoning in the wireless industry, both in terms of mobile technology and its subscribers. With all the technological advances, and the simultaneous existence of the 2G, 2.5G, 3G and 4G networks, the impact of services on network efficiency have become even more critical. The Energy consumption

Article History:
Received Date: Apr. 03, 2019
Accepted Date: Jul. 23, 2019
Available Online: Oct. 01, 2019

keeps on increasing along the line. One of the services or application that tends to make use of this network suffer from the same inordinate consumption of power, of which this project is to contribute. Geo-fencing is virtual barrier or geographical border around a single point with predefined set of boundaries on geographical area. This is mapped either with Global Positioning System (GPS) or RFID (Radio Frequency Identification) or beacons or some other technology available. Geo-fencing can also be considered as a feature of software program of GPS with a space based radio navigation system [3]. Geo-fence apps monitor when mobile devices or other physical objects enter or exit an established geo-fenced area. It involves determining the current geographical location of a mobile, comparing the current location with respect to a pre-set geo-fence and, based on a predetermined set of triggering conditions, taking actions or preventing actions from being taken. The motivation for creating a geo-fence generally derives from one of two categories of uses cases: proximity to a point of interest or location of the mobile device with respect to the geo-fence perimeter. The latter is of one of the secondary interest in this project. While the primary interest still remains the conservation of energy in geo-locational mobile apps. The coordinates of a point of interest (POI), typically expressed as latitude and longitude, and this form the centre of a circle (other geometrical shapes are also possible) of a certain radius. Service providers take pre-set actions, typically by sending notifications, when a mobile device is determined to be in proximity—i.e. inside the geo-fence—of the POI or POIs. It also provides administrators with alerts when there's a change in status for a device. These alerts or notification can take the form of text messages, e-mail notifications, phone calls or similar means of communication. Programs that incorporate geo-fencing allow an administrator to set up triggers. This project tends to be applied on schedule reminder and real time location awareness.

Many geo-fencing applications incorporate Google Earth. This allows administrators to define boundaries on a satellite view of a specific geographical area. Other applications define boundaries by longitude and latitude or through user-created and Web-based maps. The technology has many practical uses. For example, a network administrator can set up notification to be triggered, whenever a hospital owned iPad leaves the hospital grounds, the administrator can disable the device. A marketer can geo-fence a retail store in a mall and send a coupon to a customer, who has downloaded a particular mobile app when the customer (and his Smartphone) crosses the boundary. To detect geo-fence breaches, a mobile device's location needs to be known relative to the geo-fence. This requires periodic tracking of the mobile's location. The presence of the device inside or outside the geo-fence is the primary determinant for whether the notification will be triggered or not.

Unfortunately, this tracking mode is too coarse-grained for the requirements of many application areas. Take for example, location-based recommendations, where the locations of shops and stores must be mapped more accurately. Consequently, GPS is the only method that delivers the required accuracy, but experiments have shown that batteries of the latest smartphones get exhausted just after a few hours of continuous GPS tracking. This research is into the design of an energy conservation geo-fencing mobile application in the context of cloud computing.

2. Related Work

A lot of work has been done in approaching the limitation in geo-fencing and geo-locational systems at large. Series of contributions for the better performance of the system, thereby contributing or imparting the lives of people [4]. has done some work in the aspect of geo-fence limitations for mobile applications. He also worked on a replacement network proximity model describing a new location based service 'Spotique'. It is based on passive Wi-Fi tracking and Cloud Messaging. This new approach let us effectively deploy location based services indoor. It also provides a significant energy saving for mobile devices comparing with the traditional methods. In Spotique they eliminate the need to explicitly locate the client, which as a side-effect improves the privacy model. This scheme does not require from clients to send messages that explicitly reveal their location.

However, [5] carried out a research project in which the main objective of the project was to design and develop an embedded system for vehicle to detect the road accident for immediate medical help as well as for security purpose in theft prevention using single shock sensor. In case of accidental mode, the system should inform automatically via text message to medical rescue team indicating the position of vehicle location, the Geo fencing system integrate into this system enables the remote monitoring of predefined set of boundaries and automatic detect when vehicle exit from these areas [6]. also worked on geo-fencing system, and the idea behind the system was that, it makes use of a cell tower/network based geo-fencing technique to receive news alert of a particular area. By making use of the location-aware capabilities of smart phones, mobile computers, and other devices, events can be triggered when a device enters, leaves, or approaches a geo-fence [7] laid constructive criticism on this, as regards to the problems in current Geo-fencing technology. According to him, he said there are problems of the GPS precision, the privacy problems about the positional information, and problems of the power consumption of the terminals. The state that always started GPS consumes power of approximately 120 times in comparison with a standby state. Therefore, Geo-fencing technology which turn on GPS function always has a big power consumption of the terminal. On the other hand, it is necessary to increase the number of times of positioning. This is to raise detection precision of Geo-fencing technology. There is the trade-off relationship between the power consumption of the terminals and the number of times of positioning. He worked on the saving method of power consumption of Geo-fencing service by switching sensors to use at a terminal. And while doing that, maintaining the detection precision of the terminal position. But even this work seems to lack behind in the aspect of GPS positioning for Indoor system. In future work, we need a comparative evaluation of the precision and power consumption with conventional Geo-fencing.

Having known this, research suggestion and contributions are being made on this technology. According to [8], one of the most obvious methods that can be use in optimizing this power consumption is: A periodic activation of the GPS receiver instead of continuous tracking. Take for example, with typical activation periods in the range of several minutes, see, for example, [ZKS10]. More sophisticated methods use the built-in accelerometer of smartphones. Which is used to detect user movements [KL+09]. The GPS receiver is only activated when the user begins to move, and it is kept running until he arrives at a particular location and remains there. Another approach applies Cell-Id positioning per default and checks on entering of a new radio cell whether a geo-fence is inside [Ba10]. If so, another positioning method is selected that provides the desired accuracy. This method is then applied until the user enters the geo-fence or until he leaves the radio cell. Other methods for energy efficient tracking also take into account the communication overhead between device and server and propose optimizations [FCR07, ZKS10].

[9] also worked on project aiming to enable college member with mobile phone to share files with other members with an Android Phone and to share files when the mobile phone user and the PC user are both inside the home environment. In this research, they implemented a location-based task reminder application for Android-based smart phones and tablets. The application takes full advantage of the ubiquitous **WLAN** infrastructure to achieve better accuracy in indoor locationing. Furthermore, it was reported the application gives users a unified user experience because all the established personal-meaningful locations can be displayed on the Google Maps UI, regardless of the location types.

However, [10] also worked on Human Protection with the Disaster Management Using an Android Application, the notion behind this specific project was that, a number of people squanders their precious life in natural calamities such as accidents, kidnapping etc. the research project was to help the android users who are in climatic situation like this by sending some information about the location of that person who is in trouble via message to their love once, fire station, police station and ambulance. Geo-fences that will help to alert about the restricted area was integrated. Database likewise complete data of the user and the co-ordinates of the Geo-fences is store on server for accessing through the application developed, the method used here was the passive method of geo-fencing data fetch[13].

[11] also worked on a Generic approach to real time location based tracking system, this is a project whereby users will be able to select either GPS or RFID or BECONS method of geo-fencing implementation to implement the concept of Geo-fencing on the basis of requirement. [12] also Implemented a Mobile Attendance Application Using Geo-Fence Technique, the aim of the author was to show how the implementation of mobile attendance application developed using geo-fence technique to analyse the location of a person using a GPS smart phone. To operate the system, users can just tap to the application and the attendance will be recorded into the database. With a single tap, the system will be able to determine details of a particular staff using IMEI number, record an exact location from the GPS with a date and time. This is critical information that is important to store for attendance tracking. The IMEI number and the phone will be verified by the admin to make sure the correctness of the information and legitimate of the device.

Recently, [13] also worked on destination alarm notification for public transportation passenger using Geo-Fence in mobile application. The project addresses the situation whereby travelling in a long journey as to commute from one place to another in far miles using public transportation can be a very tiring experience. Thereby causing hectic and passenger tend to fall asleep throughout the journey. Statistically seating in the bus or train causing a really boring experience throughout a very far journey. Most of the passengers likely to take a nap but hard to notify and wake them up when they are nearly reach their destination and this may be causing them to miss their stops and need to find another way of getting back to their destination which may cost them double than usual. The problem is to notify passenger on the destination also affecting those disabled persons. Mostly, disabled person which suffer deaf or hearing impaired are having difficulties and some are embarrassed to ask other passenger whether the bus nearly reach the destination or not.

3. Statement of Problems

Among all the advanced communication technologies, Global Positioning System (GPS) is the utmost technology that provides very robust information of location, the idea to conduct a thorough research on this field and contribute to the existing system occurs from the several problems that have been identified even in the academic environment, this include:

1. Inappropriate draining of mobile battery on location base system (LBS) or GPS software
2. Development of unmanaged energy consumption of real time task scheduling and local aware system.
3. Inaccurate tasks schedule using location base system.

In view of the aforementioned problems, the aim of this research remains design of an optimized energy conservation geo-fencing mobile application, while the objectives are to apply Fuse Provider API client system, Evaluate the new system with the existing ones using battery performance analytics parameters to achieve the aforementioned aim.

4. Methodology

In this study, fuse provider locational API methodology is embraced. This approach differs from the existing or previous method or technique used, this, in the like of passive, cell tower or Wi-Fi Access method.

4.1 Methodological Details

As stated in the previous section (section 3.1), this study adopts fuse provider API technique for location request. The following procedures were carried out in executing this project:

i. **Review of Related Work**: Adequate research on the existing geo-locational mobile applications energy consumption level.

ii. **Data Gathering**: Information from the research conduction on the existing battery consumption rate in geo-locational application, are gathered.

iii. **Specification**: The system function (operation) shall include: integrating the new fuse provider API, integration of some library into system, and application of the fuse provider API and library into geo-fence system for reduction in energy consumption.

iv. **System Model:** The system shall be modelled in relation to the specification provided above using a well-defined Unified Modelling Language (UML).

v. **Development Phase**: This system will be develop using Google client API, JAVA Language, XML Script Language, Android Studio SDK.

vi. **Test and Deployment**: At this phase, the new system will be compared with the existing system using battery performance analytics.

4.1.1 Review of Related Work

This phase involves the extensive and adequate information review in the field of this study, part of these include extensive literature review of past research works in this domain of study and the operational review on the existing geo-locational mobile apps.

4.1.2 Data Gathering

After the review has been done on this existing work, all the necessary information as regard energy consumption rate, location request per seconds, effect of mobile device operating system on the location request, effect of mobile technology on the location request and so on.

4.1.3 Specification

The system function (operation) shall include: integrating the new fuse provider API, integration of some library into system, and application of the fuse provider API and library into geo-fence system for reduction in energy consumption.

This phase is required in this study to provide a precise idea of the problem to be solved so that the system can be efficiently designed and to provide guidance during testing and verification.

4.1.4 System Model

Modelling is widely used in science and engineering to provide abstraction of a system at some level of precision and detail. The model is then analysed in order to obtain a better understanding of the system being developed.

After the specification phase, a detailed modelling of the system was carried out using Microsoft Visio (a Computer Aided Design Tool) showing various components of the system. This phase is required in order to systematically inspect, analyse, detect and correct any system errors that may occur during the development phase based on the acquired input data. This study employs the use of Unified Modelling Language (UML), Context-diagram, Activity diagram, Use Case Diagram, Sequence diagram for the modelling of the system.

4.1.5 Development Phase

Sequels to the evaluation of data and system modelling done, a suitable system was developed using JAVA for the backend while XML Script Language, for the front end. The system will be interacting with google cloud map API and the technique for persistent location request will be integrated in the course of implementation.

4.1.6 Testing Phase

This phase of development is very important, as the new system will be compare with the existing one using battery performance analytics, and parameters like location request per seconds, battery consumption rate will be noted in both systems.

5. Design

Modelling is widely used in science and engineering to provide abstractions of a system at some level of precision and detail. The model is then analysed in order to obtain a better understanding of the system being developed. According to Object Modelling Group (OMG), "modelling is the designing of software applications before coding." In Model- based software design and development, software modelling is use as an essential part of the software development process. Models are built and analysed prior to the implementation of the system, and are used to direct the subsequent implementation.

The figure below (Figure 3.0) represent the architectural model for this study.

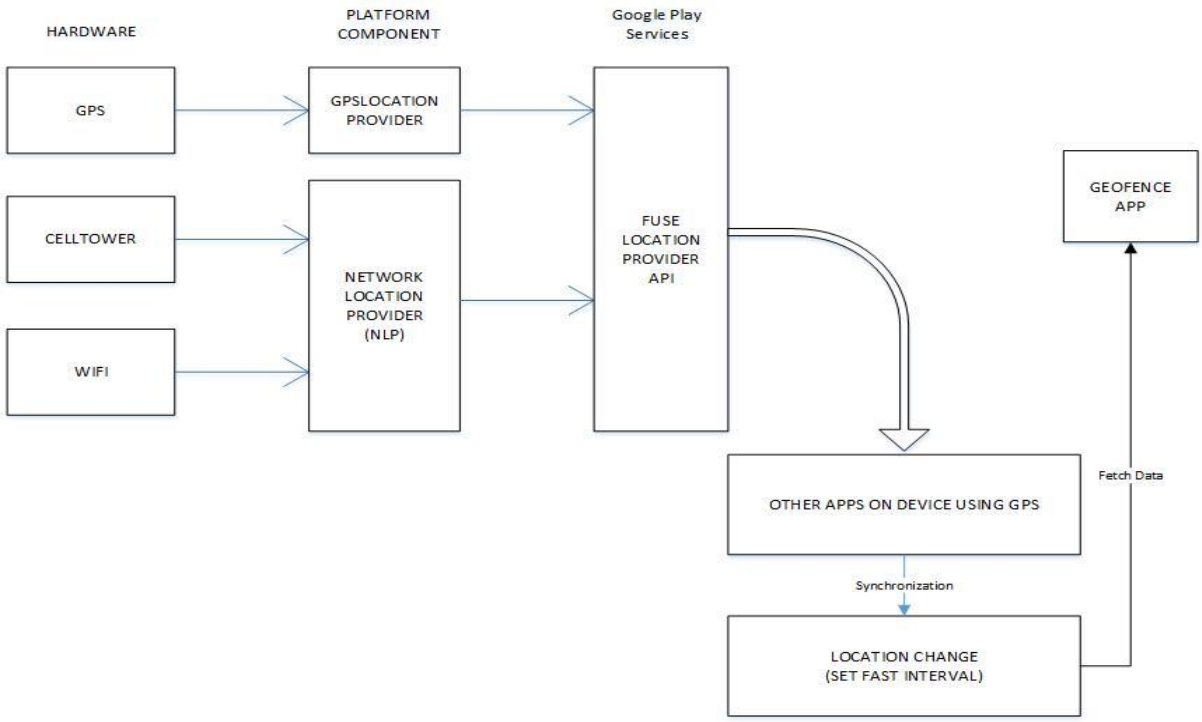

Figure 1: Overall Architectural model

5.1 Detail analysis of the model

The model given above (Figure 1) consists of three major components progressively dependent on each other, namely:

i. Hardware
   a. GPS Chip
   b. Cell Tower Network ID
   c. WIFI Access Point device

ii. Platform Component
   a. GPS Location Provider

b. Network Location Provider (NLP)

iii. Google Play Service

a. Fuse Location Provider API

5.1.1 Hardware

This component refers to chips or physically component embedded in several devices, on which the several technologies worked on, this several technologies has their own accuracy and power usage rate. Every geo-locational system will always rely on this technology, but modification can now be made on it, to optimize the power usage rate, and that is the essence of this study.

Table 1: Hardware Technologies and relevant device used

Technology	Devices embedded
i. GPS	**GPS Chip**
ii. Cell Tower Network	**Cell ID or Wi-Fi AP device**
iii. Passive	**Wi-Fi AP device**

i. GPS

According to [14], GPS is a space-based navigation system that relies on GPS satellites to provide location and time information. This system consists of 24 satellites maintained by the United States Department of Defense that circle the earth twice a day and transmit extremely precise time and location information. A GPS receiver uses this information to measure the location of a specific point on the earth's surface. GPS receivers work by comparing the time satellite signals are transmitted to the time that they are received by the unit (Figure 2).

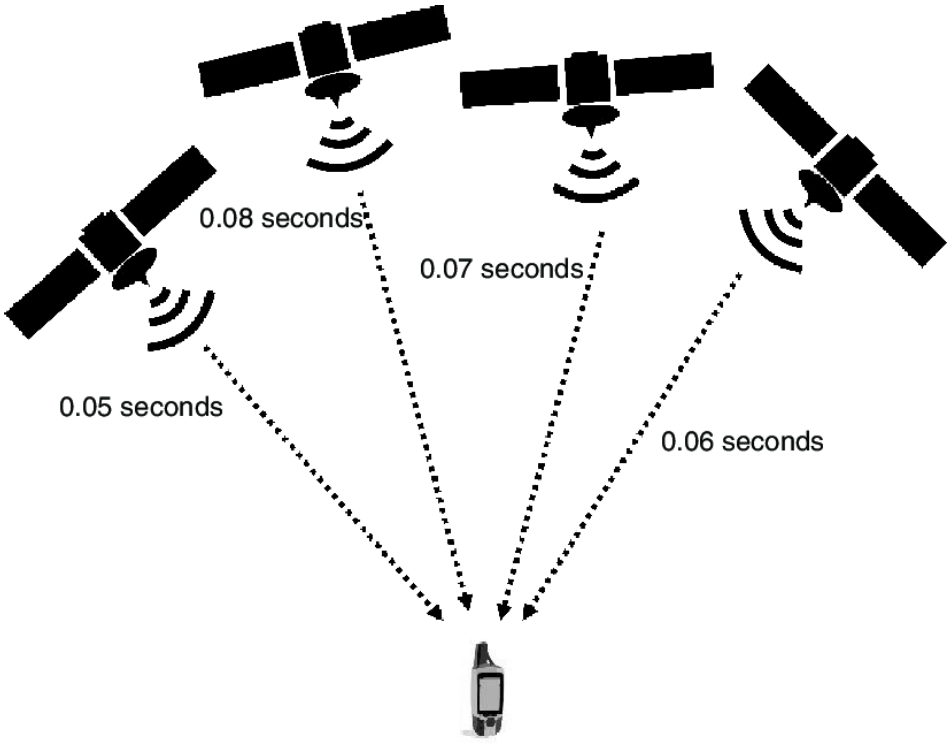

Figure 2: GPS Network

Figure 2 Illustrate how GPS works. Each satellite continuously transmits precise location and time information. The GPS receiver compares the time the signals are sent to the time they are received. This time of flight (TOF) is used to calculate the location on the earth's surface. Below are some of the examples of GPS chip:

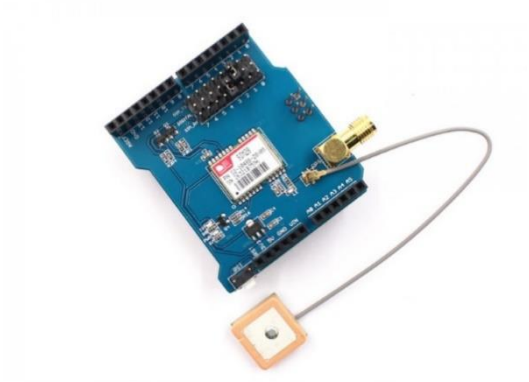

Figure 3: GPRS GSM GPS Shield (SIMCOME- SIM808)

This GPRS/GSM/GPS Shield based on the SIMComm SIM808 all-in-one cellular phone module. Compares to the SIM900 Shield, the SIM808 Shield integrate the GPS function, which makes it more convenient and cost-effective for mobile applications such as cargo monitoring, some of it features include, adding location-tracking, voice, text, SMS and so on.

Features:

- Quad-band 850/900/1800/1900MHz - connect onto any global GSM network with any 2G SIM (in the USA, T-Mobile is suggested)
- Fully-integrated GPS
- Make and receive voice calls using a headset or an external 32Ω speaker + electret microphone
- Send and receive SMS message
- AT command interface with "auto baud" detection
- Send and receive GPRS data (TCP/IP, HTTP, etc.)
- GPS L1 C/A code
- 22 tracking /66 acquisition channels
- Tracking: -165 dBm
- Cold starts : -148 dBm
- Time-To-First-Fix : Cold starts-32s (typ.), Hot starts-1s (typ.), Warm starts-5s (typ.)
- Accuracy: approx.. 2.5 meters
- Dimensions:68mm*53mm*23mm

But, based on this project, I will be making use of an Android GPS device chips called ZX808 Android OS smart 3G GPS tracker PCB board with I/O port support video Voice and SOS, this GPS technology may be known to consume energy, but in view of the plan to subject this technology to fuse provider API technique, the aim of this project will be achieved. This chip is known to be one of the predominant devices use for android device with several features/details highlighted below:

Features:

Place of Origin: China Brand Name: Topin

Model Number: ZX808 Base Material:FR4,CEM-1, CEM-3...e.t.c

Copper Thickness:1~4oz Board Thickness:0.5~3.2mm

Min. Hole Size:0.15mm Min. Line Width:0.08mm

Min. Line Spacing:0.08mm SurfaceFinishing:HASL,LEADFREE HASL

Network Frequency: WCDMA 850/1900/2100MHz+GSM 850/900/1800/1900MHz CPU:6580 intelligent quad-core

OS: Android 5.1 with I/O port programmable RAM+ROM:512MB+4GB

Positioning methods: GPS+WiFi+AGPS+3G PCBA size:45*28*4.8mm

Geo-fence: Yes SOS: Yes

Tracking system: Free APP/SMS (optional)

Figure 4: ZX808 Android OS smart 3G GPS Chip

ii. **Cell tower network**

According to [15], Cell Site with Antenna System. Cells sites are the physical towers that are located around the world which provide the ability for wireless service. They are comprised of many different hardware components, power sources, interference equipment, radio frequency transmitters, receivers and antenna systems.

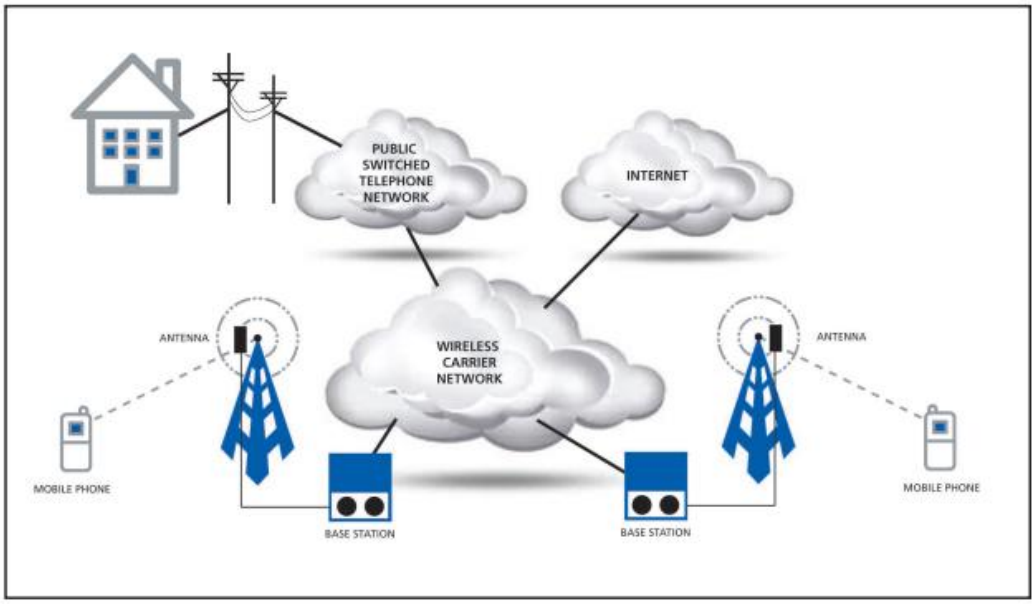

Figure 5: Cell Tower Network

One of the devices use in Cell tower technology is the Cell ID chips or Wi-Fi AP device, this is embedded into the carrier device.

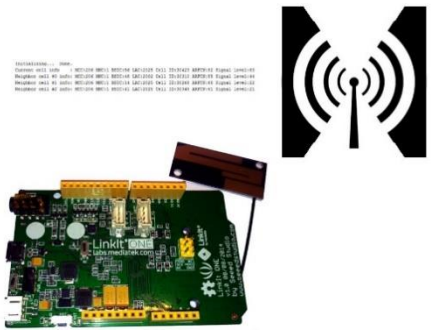

Figure 6: LinkIt ONE

Source:https://www.instructables.com/id/Explore-the-Cellular-Network-With-LinkIt-ONE/

iii. **Passive**

This technology still makes use of Cell Tower or GPS Chips, in the sense that, the method of operation is now different from Cell Tower Network or GPS chips, Passive geo-location services know where you are by asking you or by implying your location via technologies that include GPS, cell-tower triangulation, Wi-Fi access point ID, Bluetooth proximity detection, RFID, etc. These technologies keep evolving and have different pros / cons. For instance, some work better underground while others are more range or are more precise. Unless the app developer is doing something bleeding-edge, they usually must make do with what the device supports. As for how they will disclose your location, well, that depends on the app, the user, and the audience. Most time passive trackers store the information on the device and then download it to a computer. Therefore, you can only identify issues after they have occurred.

Figure 7: Passive Network Location Storage

5.1.2 Platform Component

This component depends on the hardware component to function. It is refer to Location provider platforms use in the interaction of location request between devices and satellite, it includes:

i. **GPS Location Provider**: This platform of location request is used when the mobile device makes use of GPS chip for location request. GPS is generally more accurate than network but sometimes GPS is not available, therefore you might need to switch between the two.

Autonomous GPS, Provider: GPS

1. Uses GPS chip on the device
2. Line of sight to the satellites
3. need about 7 to get a fix
4. Takes a long time to get a fix
5. Doesn't work around tall buildings
6. Power usage is high

ii. **Network Location Provider**: This platform relies fully on WI-FI access point for functionality and in some cases tower networks technology, this provider method could be refer as having two technology: Network (assisting GPS) and Cell tower or Passive provider:

A. Assisted GPS (AGPS), Provider: Network

1. Uses GPS chip on device, as well as assistance from the network (cellular network) to provide a fast-initial fix
2. Very low power consumption
3. Very accurate
4. Works without any line of sight to the sky
5. Depends on carrier and phone supporting this (even if phone supports it, and network does not then this does not work)
6. Power usage is medium-low

B. Cell ID lookup/Wi-Fi MACID lookup, Provider: Cell Tower Network or Passive

1. Very fast lock, and does not require GPS chip on device to be active
2. Requires no extra power at all

3. Has very low accuracy; sometimes can have better accuracy in populated and well mapped areas that have a lot of Wi-Fi access points, and people who share their location with Google

4. Power usage is low

5.1.3 Google Play Service

The interesting thing about this component is that, google play services provide platforms to interact on different apps on a device, this enables the integration of fuse provider technique. Fuse Location Provider API techniques combine the existing techniques (Cell Tower Network, GPS, Passive) for functionality, i.e. the ability to fully rely on other apps in the devices, that has the data needed or requested and at the same time the ability to use the GPS when no devices are present in the devices that can offer already made location request.it also coordinate the time to make location request, to be able save energy consumption.

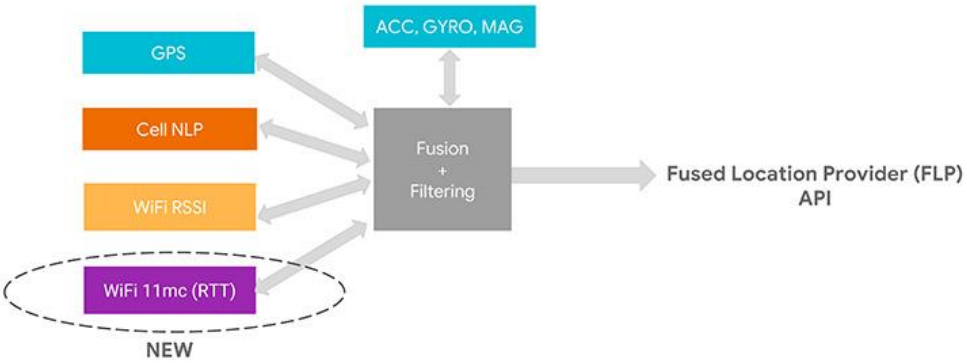

Figure 8: Fuse Location Provider (FLP) API

6. Implementation

Software implementation encompasses all the post-sale processes involved in something operating properly in its environment, including analysing requirements, installation, configuration, customization, running, testing, systems integrations, user training, delivery and making necessary changes. The word "deployment" is sometimes used to mean the same thing. System implementation is the transformation of the system designed by the system designer to actual codes and logics (working system) by the system programmer (developer) tailored to perform the tasks specified in the system specification. System implementation concerns the period from the acceptance of the system design to its satisfactory operation supported by different categories of users that can operate the system with ease. In this case we are focusing on implementation of a conserved energy system in geolocational mobile applications.

6.1 Implementation approach

The implementation approach adopted for this study is Prototyping Approach. By using this approach, the client can get an “actual feel” of the system, since the interactions with prototype can enable the client to better understand the requirements of the desired system. Prototyping is an attractive idea for complicated and large systems for which there is no manual process or existing system to help determining the requirements.

6.1.1 Prototyping Model

This refers to the activity of creating prototypes of software applications, for example, incomplete versions of the software program being developed. It is an activity that can occur in software development and It used to visualize some component of the software to limit the gap of misunderstanding the customer requirements by the development team. This also will reduce the

iterations may occur in the waterfall approach and hard to be implemented due to the inflexibility of the waterfall approach. So, when the final prototype is developed, the requirement is considered to be frozen. The implementation is channel towards Evolutionary prototyping.

6.1.1.1 Evolutionary prototyping: Prototypes that evolve into the final system through an iterative incorporation of user feedback.

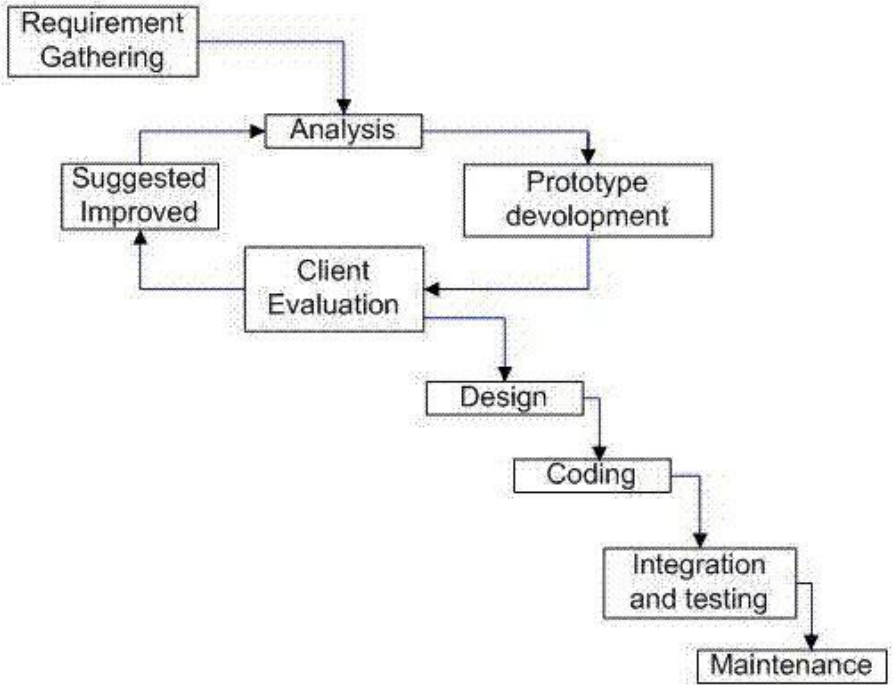

Figure 9: Evolutionary prototyping

6.2 Development environment and tools

An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development. An IDE normally consists of a source code editor, build automation tools, and a debugger. Most of the modern IDEs include NetBeans, Eclipse, Visio Code, Notepad++ and so on.

On the other hand, a programming tool or software development tool is a computer program that software developers use to create, debug, maintain, or otherwise support other programs and applications.

6.2.1 Integrated Development Environment (IDE)

This study adopted the use of Android Studio and an Integrated Development Environment. Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is a replacement for the Eclipse Android Development Tools (ADT) as the primary IDE for native Android application development.

6.2.2 Tools

The following software tools were used in this study:

i. Gradle: Gradle is an open-source build automation system that builds upon the concepts of Apache Ant and Apache Maven and introduces a Groovy-based domain-specific language (DSL) instead of the XML form used by Apache Maven for declaring the project configuration.

ii. SDK Manager: A software development kit (SDK or devkit) is typically a set of software development tools that allows the creation of applications for a certain software package, software framework, hardware platform, computer system, video game console, operating system, or similar development platform. SDK Manager is a command line tool that allows developer to view, install, update, and uninstall packages for the Android SDK.

iii. AVD Manager: An Android Virtual Device (AVD) is a configuration that defines the characteristics of an Android phone, tablet, Wear OS, or Android TV device to simulate in the Android Emulator.

iv. Google Cloud: Google Cloud Platform (GCP), offered by Google, is a suite of cloud computing services that runs on the same infrastructure that Google uses internally for its end-user products.

v. Espresso: This is to write concise, beautiful, and reliable Android UI tests.

6.2.3 Software and hardware requirement tools

i. Hardware-Requirement

The hardware requirements are the set of computer system workstations, and for efficient and effective functioning of the system, the following hardware specifications are recommended.

Hardware Type	**Requirement Level**
Battery	1800mAh Li-Ion battery (Minimum)
SIM	DUAL SIM Cards and 3G NETWORK
Display	4.0” display Minimum size
ROM	8GB MEMORY (Minimum)
SCREEN	TOUCH SCREEN
RAM	1GB (Minimum)

ii. Software Requirement

The software requirement comprises of programs and data that make the hardware to carry out the specified task.

Software Type	**Requirement Level**
Operating System	Android 4.4 KitKat (minimum)
Google Play Services	Sign In
Bluetooth/Wi-Fi	Yes
Network	GSM/WCDMA Network

6.2.4 Testing

Testing is defined as an activity to check whether the actual results match the expected results and to ensure that the software system is Defect free. It involves execution of a software component or system component to evaluate one or more properties of interest.

Testing also helps to identify errors, gaps or missing requirements in contrary to the actual requirements. It can be either done manually or using automated tools. In this study, the focus is to test the effectiveness and energy consumption reduction in geofence system, which could be an

advantage for other geolocational app when output turns out positive. I will be testing the battery consumption rate in relation with an existing geolocational network request application.

Types of testing adopted in this research includes:

i. Unit Testing

ii. Integration Testing

iii. System Testing

iv. User Acceptance Testing

6.2.4.1 Unit Testing

This is a level of software testing where individual units/ components of a software are tested. The purpose is to validate that each unit of the software performs as designed. A unit is the smallest testable part of any software. It usually has one or a few inputs and usually a single output. In procedural programming, a unit may be an individual program, function, procedure, etc. In object-oriented programming, the smallest unit is a method, which may belong to a base/ super class, abstract class or derived/ child class. (Some treat a module of an application as a unit. This is to be discouraged as there will probably be many individual units within that module.) Unit testing frameworks, drivers, stubs, and mock/ fake objects are used to assist in unit testing. Junit testing is use in testing for this study, it an android built in testing tool.

6.2.4.2 Integration Testing

This is a level of software testing where individual units are combined and tested as a group. The purpose of this level of testing is to expose faults in the interaction between integrated units, API calls and Fused provider Technique used. The figure below is an explanation of a test for the linking or bring together unit test for both the current activity and location request unit module.

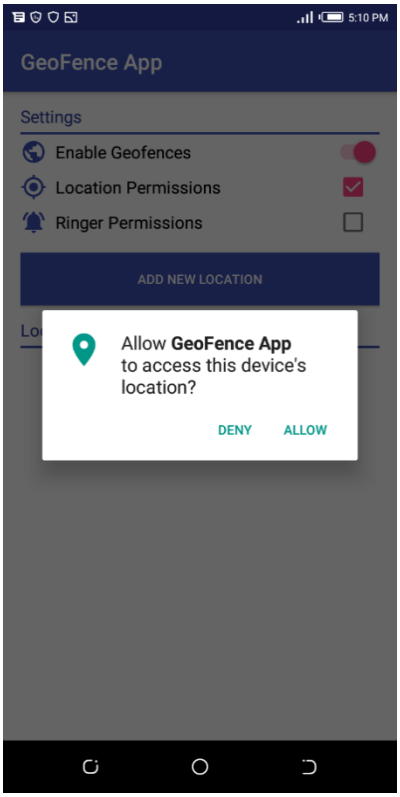

Figure 10: Dialog for Allowing or Restricting Location Request on Device

6.2.4.3 System testing and user acceptance testing

This is a level of software testing where a complete and integrated software is tested. The purpose of this test is to evaluate the system's compliance with the specified requirements.

System testing is testing conducted on a complete, integrated system to evaluate the system's compliance with its specified requirements. Software testing is the most critical phase of the software development life cycle whereby software under test goes through various phases. At this level of testing, the whole software system was tested so as to certify it conformity with the design specification and requirement.

User Acceptance Testing is a level of software testing where a system is tested for acceptability. The purpose of this test is to evaluate the system's compliance with the requirements and assess whether it is acceptable for delivery.

The figure below shows the result of the test being carried out on one existing Network fetching request mobile app and fuse provider technique mobile app:

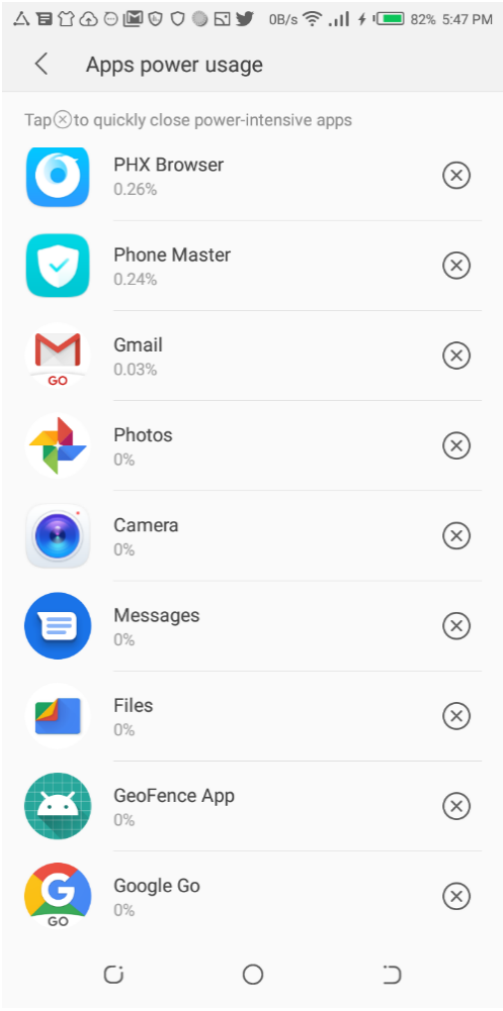

Figure 11: Activity for Battery Usage Analyzer

It turns out that subjecting the product of this study(Geofence APP) into several minute of operation on the devices it still remain O% percentage of battery usage, this is the beautiful thing about the fuse techniques integrated, it is not direct fetching from satellite but has to rely on other app currently install on the device

Conclusion

In this research, a location-based geo-fencing application was implemented for Android-based smart phones and tablets. Compared with the existing works, the application takes full advantage of the Fuse provider technique to achieve low better consumption. Furthermore, the application gives users a unified user experience because all the established personal-meaningful locations can be displayed on the Google Maps UI, regardless of the location types. The result of the model shows that Fuse Provider Technique produces a better optimized level of consumption.

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Author(s)

ALU Michael D. received his BSc. degree in Computer Science Department, Faculty of Science from Adekunle Ajasin University, Akungba-Akoko IN 2019. He is currently looking at pursuing his Masters Degree in Computer Science and/or related field.

Email: alumichael9@gmail.com
Phone Number: (+234-810) 6746804

Dr. AJAYI Olusola O. has OND degree in Computer Science from Kwara State Polytechnic, Ilorin in 1998. He received his BSc. degree in Computer Science from University of Ilorin in 2003, M.Sc. and PhD from the University of Benin in 2008 and 2019 respectively. He is into Software Engineering (Programming Languages) and Soft-Computing (Machine Learning).

Email: olusola.ajayi@aaua.edu.ng
Phone Number: (+234-703) 253-5900

Dr. AKINGBESOTE Alaba O, has B.Sc. degree in Computer Science from Olabisi Onabanjo University, Ago-Iwoye in 1994, his M.Tech was from Federal University of Technology, Akure in 2004, while he bagged his PhD in Computer Science from University of Zulu in South Africa in the year 2015. He is a native of Idanre, Ondo State, Nigeria. He is into E-commerce and Cloud Computing.

Email: oluwamodimu2012@gmail.com
Phone Number: (+234-703) 253-5900