Smart Mobile Anti-Theft Remote Tracker

An android based mobile tracker for anti-theft and parent control

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Abstract: **Smart phone is the most common electronic portable device that is used by humans around the clock. Portability of smart phone has facilitated communication and automation of daily life tasks. Besides, it beneficial usage, it has also major issues of theft and misused by children. The panacea to tackle such situation, in both cases, needs tracking by collecting information and cues. In this paper an android based system is proposed to track a device by obtaining call logs, sms logs, pictures and its location. The proposed solution is also capable of remote controlling the device by sending a specific code that works in a client-server manner. The system uses either GSM or Internet to communicate with the client. The collected data is cached in the failure of both cases and flushed to a web server whenever Internet connection is established. The salient trait of the application is to minimize battery drain, CPU and RAM utilization.**

Keywords: Android, GPS Tracking, GSM, SMS/MMS, Mobile Tracking System, Ubiquitous computing

I. INTRODUCTION

In 21st century, our lives are fully equipped with digital tools and devices. Computers are evolved from mainframe, which occupy a whole room, to tiny mobile systems. A term "post-PC" was coined in early 2010s for such mobile devices. This was called the era of Post-PC devices (PPDs) because mobile devices were preferred, which includes smartphones, tablets, and wearable devices, and reduced the personal computer sales. Tablet released in 2010 by Apple is considered to be the first PPD [1]. A study has shown that there are 4 billion subscribers up to the year 2010 and production of mobile devices are continuously increasing at the rate of one billion per year[2]. Along the benefits, portability has introduced some major challenges e.g. device damage, privacy, data loss, misuse by adults and theft.

M.Satyanarayanan has categorized these challenges in four categories [3]

a.   Mobile elements such as CPU, memory, storage are resource-poor.

b.   Such devices are hazardous and can be stolen any time any where

c.   Mobile connectivity for internet or other resources are variable because of buildings, bandwidths etc.

d.   These devices are highly dependent on finite-power

Portability of mobile devices expanded the risk of data loss, physical damage of the equipment and theft [4]. A study was conducted about phone theft and 470,000 phone thefts were estimated by British Crime Survey in 2000.These robberies were done by teens having 16 year old or more [5].

Another addressable and sensitive issue for the society is smartphone abuse and addiction. This is a more problematic situation for parents. One report shows that majority of the users are adult and utilize their smartphones for communication and friendship on social networks like facebook, twitter or whatsapp. Most of the higher level school students/adults uses their smartphones for maintaining social relationship e.g. voice calling or messaging with boyfriend/girlfriend [6]. Yet another research calls it smartphone poisoning. This means that overuses of smartphone without any motivation and perceive unease without smartphone [7].

Varying approaches has been adopted for such malformed activities either to prevent or track. Prevention involves avoidance that can be pre-installed security software. Tracking is the post-step if such pursuit is occurred and assists to reveal cues to reach the desired goal. Application should not be depended on internet. The question arises is that what if there is no connectivity to the Internet or the device is used indoor? The software should be smart enough to interchange alternate methods, collect information and send back to the owner if a device is stolen and being used by the thief.

The paper aims to provide a solution to the above issues by proposing an android based application called SMARTy. Smart Mobile Anti-Theft Remote Tracker (SMARTy) is a client-server based tracking system that tackles certain problematic situation of power consumption, memory usage and interchangeable methods of using either internet or SMS to send feedback. A detailed scenario is depicted that will help to better understand the case of theft and parent control. This paper discusses only the two aspects "Mobile Theft" and

"Parent Control" and proposes a software based system that how to control above described situations.

A scenario is given to better understand the functionality of the application.

Scenario 1:

"Bob is a hard working graduate level student and has been given a gift, which is an android based smartphone, by his father for taking position. To track and avert Bob from bad activities, his father has already installed SMARTy on his phone. One day, when he is on the way to attend the classroom; he received a call from his school fellow Alice. She invited him to join a party right now. SMARTy fetched the incoming call number and sent to his father mobile. However bob did not care for such invitation and put his mobile on silent mode in class. Suddenly he received a text message: "we are going for outing to Boston if you interested then come to the exit door of the institution" from one of his adventurous friends. Bob replies with "yes" because he is fond of picnic and photography. Fortunately, SMARTy is keeping eye on his activities and sent both incoming and outgoing text messages including the text body and phone numbers to his father's mobile number. His father sent a code to start fetching continually bob's location using GPS while on journey to Boston. Bob's father is now receiving SMS containing the bob location by SMARTy. Now bob started photography while reached to Boston. His farther is also informed on each image capture using SMS by SMARTy. His father gets worried about him and thinks that he should be in class room not at picnic point. Bob's father sent a code to bob's mobile and remotely locked the camera.

On the way, going back to the school, his smartphone was stolen by a burglar. Bob informed his father about certain situation. On the next day, bob's father received a text message from a number that the thief has changed the SIM but still using the phone. He send a code to activate the SMARTy in stolen mode on the target device. Now SMARTy captures an image on each call receiving/dialing and stores on a server. Later, bob's father, login to SMARTy server and was shocked to see the images that it was bob's friend who stole the phone from his son"

The paper has been divided into the following sections.

Section II describes the related work to the proposed application. Section III explains that why android platform has been adopted. The detailed SMARTy architecture is described in section IV. Section V describes the method that how the whole system works and in section VI shows analysis and results for battery and memory usage.

II. RELATED WORK

In the past, many researchers worked on different mobile device platform and adopted varying methods to develop a tracking system. Every approach has unique feature with regard to a specific perspective but has lack of qualities.

One approach that has been adopted by the researchers is utilizing Multi Media Message (MMS) on android platform to track a burglar [8]. This technique has two limitations. The one is that it uses more memory as well as drains power frequently due to the running services and capturing videos. Another limitation of this approach is vulnerability of hacking android systems discovered by Joshua Drake in august 2015. Google has provided a framework "Stagefright" for sending and receiving MMS on android but this library has a vulnerability that can lead any attacker to get control over camera, microphone, sd card even access to the root [9]. Another approach for tracking a location taken by the researchers is to use a specific kind of microcontroller that is entirely depended on GPS/GPRS and will not work correctly in cloudy weather or without Internet [10]. Android Based Energy Aware Real-Time Location Tracking System (EWAREL) has followed the same approach of GPS but with intelligent coding to preserve battery life [11]. This technique uses Java listener classes, which are provided in android SDK, for the battery power e.g. if the battery power near to down, it stops working and return the last best possible location coordinates. K Sujatha and his colleagues have taken on the same methodology for a bus location tracking [12]. A bus driver has to own and android based smartphone and should installed the application. HCCTS is a LAN (Mesh) based tracking system that is used for children location. Information is distributed among android terminals and stored on a server [13].

All the discussed approaches rely on GPS and have not interchangeable methods of utilizing either internet or SMS. Android based cellular device is more beneficial for tracking a person than creating a device from scratch.

III. WHY USE ANDROID BASED SMART PHONES

There are different smartphones available in the market that comes with a variety of OS like Android, iOS, Windows, Symbian etc. Each product has its own features and software license e.g. Open source, commercial etc. The interesting aspect of both platforms is that they provide Software Development Kit (SDK) for 3rd-party contributors to develop their own software according to their framework. One of a report in 2009 with regard to OS based, android was on fifth number and sold 6,798.4 Units in the Year [14]. The competition started between android and iOS by supporting their users for app store and SDK as well. These two competitors raised their graph to the peak in 2013. Android sold 758,719.9 units and iOS sold 150,785.9 and gained position first and second respectively. The second major difference is that android is open source and any company can customize ROMs for their needs while iOS is closed. The third important feature of android is ease of access to its play store. Anyone can put their application on the store and download as well while iOS has strict rules to participate its app store [15].

IV. SMARTY ARCHITECTURE

SMARTy is an astute tracker that functions on client-based architecture. Client, which can be any cellular device, sends

queries to the server (SMARTy installed on a device) and get response either by GSM or Web Server. Figure 4.1 shows the detailed architecture of the proposed system.

Figure 4.1: Smarty Architecture

SMARTy architecture consists of three major components which are core components of the system. These components communicate via SMS or HTTP post methods.

1. Server

An android device that needs to be tracked is a SMARTy server and works as the heart of the system. Server receives requests from a client, response queries and sends back the desired result to the client or stores on a web server for later manipulation by the user.

2. Client

A Client can be any cellular device that works on GSM network and has the capability of sending Short Message Service (SMS). Communication between client and server can be achieved by using SMS. Client dispatches SMARTy commands to the server, which are further utilized by SMARTy, and the result is calculated according to the commands.

2.1 SMARTy Commands

Like other client-server based communication systems, SMARTy has its own set of commands that differentiate from other incoming messages. SMARTy command comprises of four parts that can be better understand in the illustrated prototype. GSM technology is used to share information between client and server. Furthermore server uses HTTP requests to store information on SMARTy server.

[msg identifier].[password].[action][value]

- *Message identifier is a unique string that differentiate it from other incoming messages*

- *Password part consists of the pass code to verify the message that it has been sent by the owner.*

- *Action can be a command to achieve a particular functionality or property name that needs to be set by the client*

- *Value is an optional part of the query. It can be used to set a particular settings property that is used by SMARTy.*

If a user wants to turn off notifications coming from the server then the following command will be sent by the client:

SMT.asdf2ky.NOTIFICATION.OFF

In the above mention code **SMT** is a message identifier, **asdf2ky** is password, **NOTIFACTION** is the property of the server settings and **OFF** is value for this property

3. Web Server

SMARTy web server is an alternate source to store query results when SMS is not available due to some reason. Any SMARTy user must register to use this alternate source and can login to process the obtained uploaded data by the application.

There are two types of communication involved in smarty architecture. One is client server and the second is server-web server. The overall architecture is explained below.

1. Client-Server Communication

Client can be any cellular phone that can send SMS via GSM. Client sends specific commands to the server to retrieve desired information about the target (server) that can be an android mobile phone. Server sends back information to the client via SMS or store in a cache table for future manipulation.

Figure 4.2 Client-Server Communication

2. Server-Web Server Communication

If Client-Server communication fails then Server saves the desired information in a cache table. So after establishment of Internet connection, server fetches the data and posts to the smarty web server on behalf of the user. User can retrieve all the posted data by logging to the smarty web server through a browser.
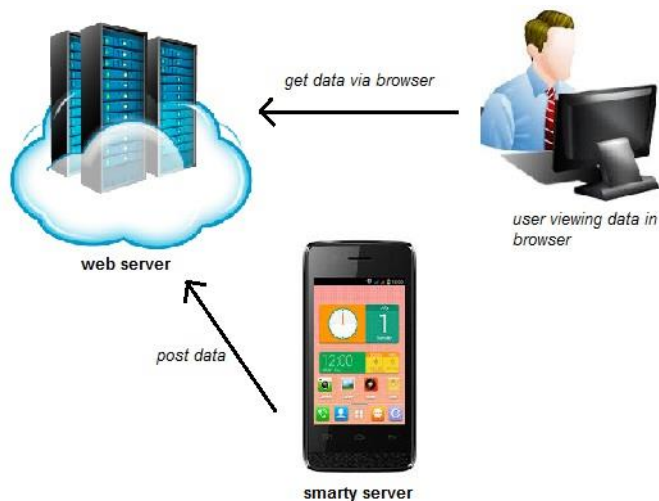

Figure 4.3 Server-Web Server Communication

Objectives:

- *Monitor the incoming/outgoing call numbers and give feedback using SMS or Online Web Server.*

- *Listen silently for incoming/outgoing short message services and notify the client including the number and message body.*

- *Wipe phone storage on sudden mobile stolen if it has some personal data e.g. pictures, videos by sending a specific code through SMS.*

Features:

- *Notify the client on each SMS sending or receiving including the destination address and the message body.*

- *Send notifications to the client if a number is dialed or received*

- *Inform the client if an image is captured. This event is occurred on each image capture.*

- *Send the Geographic Coordinates to the client if GPS is enabled.*

- *Client can wipe the android server remotely by sending a specific code without know the server but the side effect is that server will be deleted while wiping the data.*

- *Client has the capability of locking/unlocking camera remotely.*

V. METHODOLOGY

Reliability is a quality of best software engineering design. Software should work seamlessly if certain failures occurs and be instinctive and shrewd to adopt the environment. SMARTy has also such capability to espouse interchangeable approaches if one fails.

Different functionality has been considered to collect information that assists to track an individual e.g. call logs, sms logs, images etc and process the information. SMARTy is a module based application and has three basic processes that can be elaborated in details

1. Collecting Information:

This is the basic step that is executed in background. SMARTy listens for the events of incoming/outgoing calls, incoming/outgoing messages, GPS coordinates, image capturing and records the metadata related to the event.

2. Process the data

The tricky part of the application is processing of the collected information. SMARTy has two choices either send the data using SMS or upload to the web server. First the data is sent to the client by SMS but if it fails to deliver the message then it will examine the data connection to store the information on the server. If such condition meets then the data will be uploaded on behalf of the user, else it is cached in the data pool. The data flow has been illustrated in Figure 5.1 for the above process.
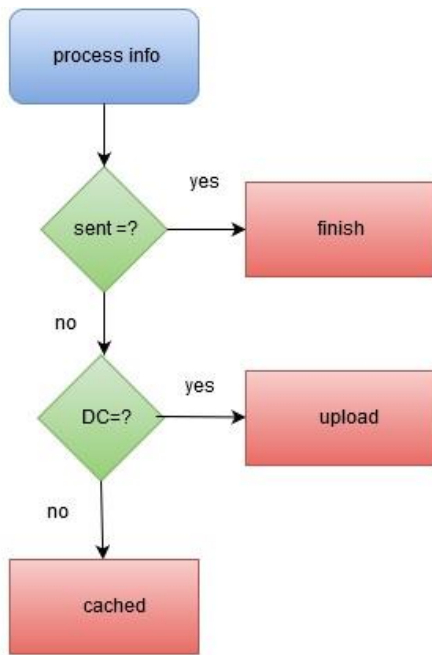
Figure 5.1: Data flow diagram for sending information

SMARTy will also listen for data connection change event. If this event occurs and internet connection is established then the application will check for data in cache, if data is available then it will be uploaded on the SMARTy server. Figure 5.2 shows the data connection event process.
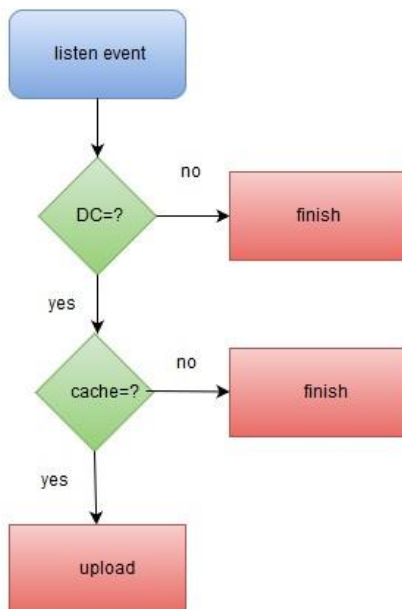

Figure 5.2: Listening for data connection change event

3. *Power Consumption*

GPS is a unique navigation system developed by U.S Department of Defense in 1970. This system was used by military of U.S but now publically provide to civilian. It can be used to obtain a position anywhere in the world [16]. Different android applications have been developed to track the location using the Google APIs. But the negative point of tracking location continually is power consumption. Recently Google has introduced Fused Location API to get the position coordinates. This API has four modes but with varying features that is provided in table 5.1 [17].

Table 5.1 Fused Location API

Priority	Intervals	Battery drain per hour	Accuracy(M)
HIGH_ACCURACY	5	7.5	10
BALANCED_POWER_ ACCURACY	20	0.6	100
LOW_POWER	20	Small	10,000
NO_POWER	N/A	Small	variable

SMARTy will continually observe and analyze the battery power. If the power is less than 50% then the priority will fall down from HIGH_ACCURACY to BALANCED_POWER_ACCURACY.

VI. RESULTS

Introduction of the best engineering techniques has differentiated SMARTy from other tracking systems considering battery drain, memory usage and CPU utilization. Result has been calculated using a tool "GSam Battery Monitor" that shows the battery statistic by all running apps in android based smartphone.

Figure 6.1 describes the power consumption of SMARTy which is 0.2% and is extremely low as compared to other android apps.
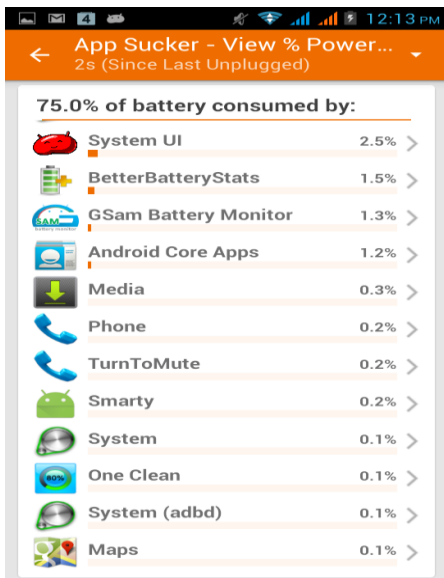
Figure 6.1: Power Consumption in percentage

Another aspect, which is more important, should be considered is memory utilization while developing any android application. Memory support in smartphones is quite expensive. So the approach that has been used for the system is to avoid services as much as possible that continually run in background. Figure 6.2 illustrates the initial memory utilization of SMARTy (5.4MB) that is stated by "android app manager"
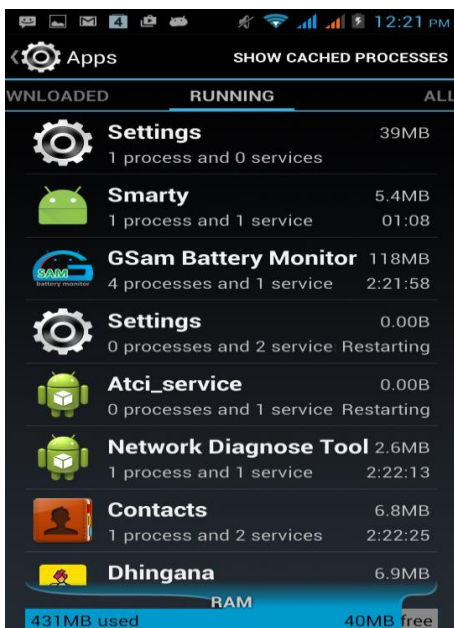

Figure 6.2 Memory Statistics

The proposed system does not entirely rely on one aspect for tracking a device. It uses alternate approaches, which will be interchanged automatically if one is unavailable, and helps to collect information about target device. Different features have been compared with other tracking systems in table 6.1 that should be contemplated while selecting the best one.

Table 6.1 Compare Statistics

Tracker	SMARTy	Anti-Theft Application	Real-Time Vehicle Tracking System	EWAREL	Mobile Bus Tracking	Hiroshima City Children Tracking System
Device Type	Smartphone	Smartphone	Linux Board	Smartphone		Android terminal
GPS Module	✓	✓	✓	✓	✓	✓
SMS Notification	✓	x	x	x	✓	x
MMS Notification	x	✓	x	x	x	x
Online Notification	✓	X	✓	✓	✓	✓
Caching data	✓	x	x	x	x	x
Remote Administration	✓	x	✓	✓	x	x

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DISCUSSION

It is important to discuss some positive and negative aspects of the application. The application that has been developed for Android based OS, has some functionality that has been left visible deliberately e.g. its launcher icon, sent notifications and received commands remains visible in inbox. As Google says that it is a bad experience to send SMS in background and they blocked such abuse in KitKat 4.4 and above versions. So it is a client-server based communication not a Droid Trojan. Another weak point of the application is that it can be uninstalled or removed if hard reset is done by the user and need improvement for permanent install. One solution is that the application should be installed prior as system software in a stock ROM by company.

CONCLUSION

Different approaches have been proposed for tracking or obtaining Geographic Coordinates using GPS. The methodology should be quite intelligent to achieve a goal and methods should be interchangeable if one fails. In this context, SMARTy is also intelligent software that automates its process and completes the desired gracefully. The server application notify the client using SMS but if any failure occurs, data is cached and waits for a network connection. If it detects a

working internet connection then post the data to SMARTy Web Server using HTTP Post method.

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