Architecture for Employee Tracking SystemUsing Smartphone

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Abstract- Using GPS devices for tracking employee, vehicles are becoming outdated now, when most of the people are using Smartphone's, there are many applications which helps in trackingvehicles, children's, women and etc.

We can also use Smartphone to track employee, but tracking employee is very different from others as the employee generally works 10hours a day, soturning on GPS for such a long time and sending data continuously to the server, the battery running for such a long time in today's situation is not easy. This paper providesa solutionfor trackingemployee for a long time without draining his battery and without losing data.
The employer can check which path his employee is using to travel, at any point of time the employer can see where his employee is currently; at what time exactly he visited defined locations and etc.

Index Terms- Battery efficient tracking system, Employee tracking using a Smartphone, Employee tracking using GPS and Network, good architecture for GPS based apps.

Introduction

One in every five people in the world hasSmartphone, Smartphone with its attractive features, price starting from just 3k onwards has become part of every one's life. Able to install custom apps from the market, GPS, Location through the network, use all social media sites and e-commerce sites through their apps are most popular features.
There are many companies where they have a need to track theiremployees periodically throughout the day reasons being to avoid employee cheating the employer by not visiting the places he has been asked toor to track employee performance by real-time data or showing miscellaneous expenditure without actually spending or using it example, travelling charges.
There aresome solutions, where some are using handheldGPS devices and some already have apps for tracking through Smartphone but they are not efficient as most of the apps are not well designed, so it will not survive for more than 6 hours a dayasit has to work complete day with GPS on and update being taken every 10minutes or less.

This paper providesa solution to the above mentioned problem - the best architecture for developing battery efficient employee tracking systems in fact, any app which uses GPS and sends data frequently can use this architecture.

This paper is organized as follows Section I is an Introduction to work.Section II will be related work. Section III we will explain complete system, its design and how it works. Section IV is the conclusion and future work.

Related work

Although there is no exact work on employee tracking there are different tracking application we found.

A. Al-Mazloum, E. Omer, M. F. A. Abdullah work on GPS and SMS based tracking provides solution for tracking children by parents using Smartphone's, they propose an architecture which includes two Smartphone's one being client(child) another being server (parent), whenever parents wants to track children, parents will send request through SMS and on client side the active listener listens to that specially formatted message responds back with location details and then on parent side the location details will be presented on map.

B. In Almomani, Alkhalil, Ahmad and Jodeh work they track vehicles using GPS, GSM modem, GPRS andit is client-server model, when a user requests a location from web or mobile, a SMS will be sent to the GSM modem, the client then responds using GPRS which will be received by GPRS server and send to GSM modem which in turn sends to server.

C. Chandra, Jain, Qadeer used a simple web server based approach along with SMS for Java based mobiles equipped with GPS receptor.A client can send his location details either directly through SMS or send to the server using the internet. The main aim of this work is to enable user to share his location with friends or some other people.

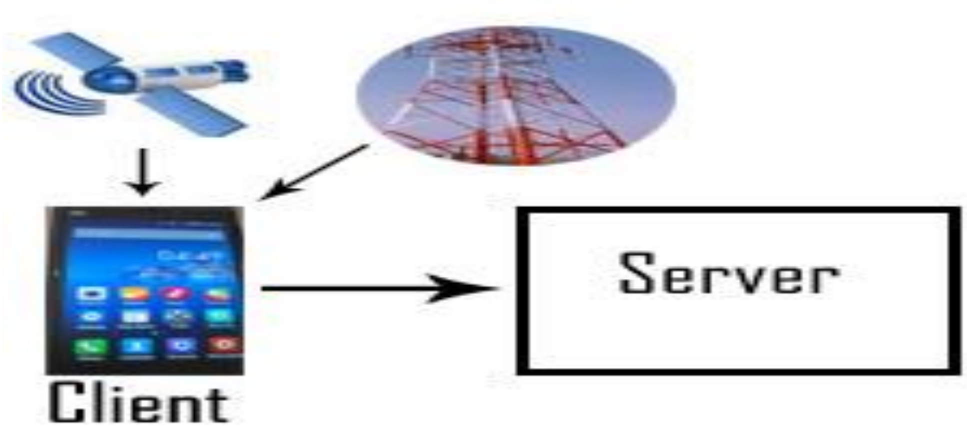
As it can be established from a related work review, there are many solutions which can be used to find or track employee. Some of the above mentioned architecture requires GSM modems or SMS functionalities of a mobile to share location and it is complex in architecture, also SMS functionality cannot be used when we need frequent location update to be sent to the server so GPRS is a good solution. But there is no solution where we can continuously track employee without his interaction and getting location from multiple sources, as waiting only for GPS coordinates drains our battery. So this proposed application solves these problems

Application development

Requirements

This work is designed for employers to track their employee, but it can be used by anyone who wants to track other person with prior permission as this application needs to be installed on the person whom we are going to track.
This application is developed using the Android SDK and eclipse and server side is developed using PHP and tracking is plotted on Google maps using JavaScript.
For this application to work properly the location services should be turned such that the app can get location through GPS or from the network.

Application Architecture



This system consists of two components: Client and Server.

The client will be the android application or android phone, it is designed in such a way that it has very few elements and very less user interaction and the interval at which location updates are received can be either hard-coded or selected, but ideal timing will be every 10minutes.

In this system server will receive data sent from the client side and it will save it in a database and display to the end-user who will be the employer or the person who wants to track on map.

The above mentioned problems are being solved with two main components: GPS and Network; these two features are present in almost all smart phones now.

For first time once user installs the app he should start the app and after that every 10minutes or any predefined time the application will start automatically and fetch the location and send to server.

Instead of having a loop inside the program we use feature of android called alarm manager which will take time interval as the input considering interval timeas x, so the app starts repeating every x time period automatically. This ensures that the app is started only when it is needed at regular interval automatically.

Whenever the application starts , the app starts listening to GPS and network location, as already known,location can be obtained through network very fast (maximum being 2secondsaverage) , but with the GPS maximum average being 25seconds so this is the area that is focused for reducing battery.

25 seconds of GPSconsumeapprox: 1mAh.

Whereas 2seconds of network consumes approx 0.1mAh.

Then why don't we go only with network, answer is accuracy GPS gives us average 10meters of accuracy and depends upon the location of mobile if under clear sky, we will get location, fast and with very good accuracy, in close location you may not get location at all for hours, where network depends upon location of source, if we are gettinglocation from mobile network or mobile tower then every 4km one tower is placed and getting location from WIFI depends on how far you are from it, using both is a good idea as it can save battery a lot.

Imagine the situation where GPS starts and the employee is inthe office or closed location until he comes out GPS will run continuously, thenevery 10 minutes average 25 seconds will cost us

Then for 1 hour, 10 minutes * 6 = 60 minutes

25 * 6 = 150 seconds = 2.5 minutes = 6mAh per hour approx, so great your 3000mAh battery will give you backup for 500hours. But is this the only thing you or your employee does with his phone? Messaging, calling, browsing, even our app sends data to server will cost us battery right.

The most important thing to remember whenever we are waking our application it's not just the application that wakes up, but we are waking upthe CPU of our mobile which was in sleep mode so this will also trigger other applications to update or do their own processing, so every 10 minutes we are waking up the CPU and other apps that will again drain our battery.

This is the main reason we are getting average 1 day battery backup with our batteries. So how can we optimize our application now?

As we are using two providers, GPS and Network will start listening to both, not for infinite time but for finite time.

We are going to fix deadline of 10 seconds, which is less than average, butaccording to our research when under open sky, location from GPS will be obtained within the deadline period easily and network of course maximum average time being 2seconds. So every 10 minutesthe app will be started and only spend 10 seconds for getting location and if location is obtained before this 10seconds, then the app stops listening for locations and do further processing. This is the most important part where we are saving the battery to the core.

If location is obtained from both GPS and Network, then, according to the accuracy the app considers one location and ignores another location, thisensures that the app is accurate.

Another problem to be addressed is, are we going to consider all location updates, if it is accurate. An employee can be standing somewherefor some time more than 10 minutes so taking multiple location update from same place creates a problem when we plot all location data on map and even sending unwanted data is waste of bandwidth and battery of that employee. So the solution will be to filter the data which will be useful.

This provides proposes distance filtering of data, whenever we get new location update, it will be considered only if it is x meters or km apart from the previous distance. So new location update will be considered only if the employee has travelled minimum distance from his previous location, else it will be ignored as duplication, this saves battery because an employee will not travel continuously throughout the day..

Next, once the app gets a location, it needsto be sent to the server, but opening and closing a network connection every 10minutes is again not a good idea from battery point of view. Below is the solution provided for this problem.

Depending upon user requirement, if user wants to track and see data in real time, thenthe app needs to sendthe data immediately once it gets the location else if the user is okay with some delay, thenthe app can store all the received locations in local database and send all at a time after some predefined hours or end of the day or also use another android feature called bulk data transfer.When bulk data transferis used, instead of opening network connection and sending data every 10 minutesthe app pushes to queue and whenevera userwakes up the system or any other app wakes up the system all data in the queue will be sent to the server.Thisensures that the battery is not drained every ten minutes by opening network connection and starting other apps to do a network transaction indirectly. So batteryis saved very much right there.

Also in this appa database system called SQLite is used to make surethat the data is stored in the same order as it is received to avoid lossof data when there is no network connection.

At last once data is stored inDB or pushed to network queue or sent data directly then the applicationstops immediatelyand this ensures that the app is stopped when it has finished the work.

As specified from very beginning of the paper that 10 minutes is ideal interval time to get location, but the ideal time should usually vary according to mode of travel of the employee. So if he is riding bike or car, 10 minutes will be late because when we plot data on map we may not see the route properly.

This paper provides solution called dynamic timing, app is going to change time interval for getting location dynamically by determining his speed of travel. We are going to find speed using our basic math formula.

$$\text{Speed} = (\text{distance} / \text{current interval time})$$

Using this the app dynamically predicts the mode of travel and changes its current interval time accordingly, because average human walking speed is 5km/hour or 3.1miles/hour average, a average bike speed is 30 – 50 km/hour inside city and 60-80km/hour outsidethe city and average car speed outside city is 80km – 120km or more so using this simple assumptions the app will predict speed and change the interval time, so increased interval time means app will start with more interval so if app itself starts late then it obviously saves battery.

So making sure our application runs for least time by using minimum resources in a very efficient way and ends as soon as it has finished is the motive behind this system and best practice to be followed by all app developers.

Conclusion

We would like to conclude saying that there is much more room to improve, one thing is AGPS we would like to dig deeper into this feature as this is becoming very common now and the understand best way of using wake locks as we use wake locks in this system but we still need to learn and try many things on that part. Another very part to examine is how android system reacts and kills our app as the user interaction is very less in memory critical conditions and how to improve that for less user interaction app like this.

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