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Geolocation Android Mobile Phones Using GSM/UMTS

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Abstract:

The proliferation of cellular network enabled users through various positioning tools to track locations, location information is being continuously captured from mobile phones, created a prototype that enables detected location based on using the two invariant models for Global Systems for Mobile (GSM) and Universal Mobile Telecommunications System (UMTS). The smartphone application on an Android platform applies the location sensing run as a background process and the localization method is based on cell phones. The proposed application is associated with remote server and used to track a smartphone without permissions and internet. Mobile stored data location information in the database (SQLite), then transfer it into location API to obtain locations result implemented in Google Maps. Track a smartphone with fixed identifiers mostly SSN (SIM (Subscriber Identity Module) Serial Number) and IMEI (International Mobile Equipment Identity) derived from an identifying string unique to the user's device. The result located place is Moderate correct according to the (GSM) and (UMTS) cellular networks which is used for obtaining location information.

Keywords: GSM/UMTS, Mobile device, MySQL, Tracking, Web services.

Introduction:

The cellular wireless systems offering reliable mobile location estimates have been studied by engineers and researchers for the past few years because of its temporal/spatial nature and rich context (1). The mobile devices localization has become important topics in wireless communication, GPS consider high accuracy but the most battery power consuming only a few hours, despite of low accuracy and low cost regarded as the basic cellular communication systems, transmitted over the control channel owns short response time. The GSM/UMTS can be used to be obtained location information without additional external hardware when there is cellular coverage (2). Location Based Services (LBS) with the popularity is smartphones that have grown rapidly over the past years and market forecasts show similar growth in the near future. As the need for tracking mobiles in our daily life is increasing, it became tracking thousands of users periodically on the scale of minutes, focuses on cheap and cellular networks independent tracking solution that does not need any hardware change within the core network and that can find any mobile terminal.

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Tracking smartphone by exploiting a permanent mobile data connection, each data packet received provides up to date location (3). Location tracking applications have proliferated in mobile cellular network and have gained access to a great deal of sensitive personal data; these seek the power to conduct tracking covertly and without a judicial note, that track people go through the personal mobile with (GSM/UMTS) chipsets (4).

This uses the mobile for tracking the location, the phone's location that obtaining by GSM/UMTS network used the location information consisting of Cell ID (Cell Identifier), LAC (Location Area Code), MNC (Mobile Network Code) and MCC (Mobile Country Code). The location information is stored inside internal database (SQLite) in mobile periodically, it is possible to show a mapping that aims to give an overview of tracking for mobile. This map gives the distribution of location for each region visited by user (5).

The contributions in this paper can be summarized as follows: we utilize location information for a mobile device that is always available in the cellular network. We create an application of an efficient, easy-to-use, and inexpensive mobile device tracking system, the application provides a better balance between battery power and location accuracy. Through the location information collected during the roaming

of the mobile device between the base station connected them, this information enables us to track the mobile device to see the location visited (historical location profiles), the application can be used in any place in world covered by GSM/UMTS signal, compared the location information with high-level API to provide a positioning system. This work provides proactive services which automatically tell their users when they enter or leave the bounds of pre-defined points of interest.

Related works

S. Theerawisitpong, et al (6). The challenges include detecting problems air-interface signal over GSM cellular network, an investigation about the examined and corrective approaches used.
Chandir Subhash, et al (7). The study presented an improved access to children and insure a vaccine against diseases for poliovirus, the traditional way is moving door to door campaigns in constrained by several factors that resulting in optimal vaccine coverage. It provides a solution of low-cost used GSM based tracking of the mobile subscriber identity of vaccinations, investigate the feasibility using GSM to track vaccinations through effective monitoring for supervisors and managers.
Alicia Rodriguez-Carrion, et al (8). The advantage of location prediction in an ubiquitous using GSM is to obtain lower resource consumption or better prediction accuracy, estimating the next location Utilization of LZ-based on algorithms capable of learning mobility patterns.

Muharum A. M., et al (9). discuss proposes an energy saving API for the Android Operating System in order to help developers who have main features heavily used for building smart applications, greatly impact battery life of Android devices when the location is determined using the cellular 2G / 3G network and the maps.

Rafael Roberto, et al (10). This paper presents many tracking techniques proposed recently taking into account the benefits and limitations of mobile devices. The results show that the number of publications is increasing every year in the field of tracking for mobile devices, the most works use the mobile device sensors for tracking in location-based applications, there is a clear preference for systems that calculate the pose locally on the device and only a few of the remote server.

Fritsche Carsten, et al (11). The usage of mobile terminal Tracking, if GPS is not available when the mobile terminal is located close to high buildings. That approach is to combine the GPS measured values with measured values from the GSM. This work depends on the base station location to accomplish tracking.

Theoretical Background

1. GSM primer

GSM network structure is divided into base station subsystem and core network that is shown in the Fig. 1 (3), The GSM technology based on Time Division Multiple Access (TDMA) transmission methods and used to describe the protocols used by mobile phones for the 2G digital cellular networks, the Base Transceiver Station (BTS) is responsible for the radio coverage of a given geographical area, while the Base Station Controller (BSC) maintains radio connections towards mobile stations of the core network, both BSC and BTS join the Base Station Subsystem (BSS) that controls the radio path. The GSM service area is divided into Location Areas (LAs), where each LA includes one or more radio cells the LA and radio cell has a unique identifier named LAC and Cell ID, the Mobile Station (MS) comprises the mobile phone and the Subscriber Identity Module (SIM) card and interacts with the BTS (12).

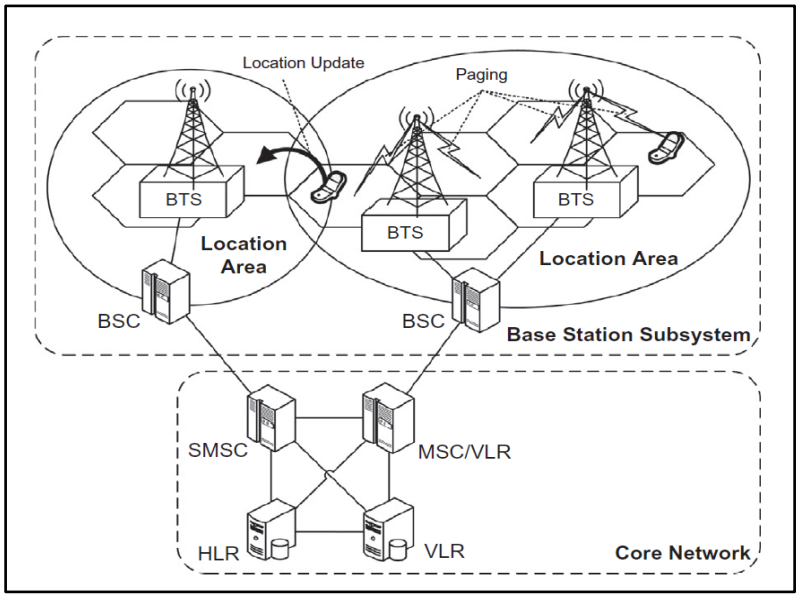


Figure 1. GSM network [1]

Each cell in the network is uniquely identified by Cell Global Identity (CGI) number which consists of four numeric fields: MCC, MNC, LAC and Cell ID, implemented in the query MCC, MNC, LAC and Cell ID, deals with obtaining the location information from the GSM network. The GSM core network mainly includes the Mobile Switching Centers (MSCs) which is a network element responsible for circuit-switched services, a special type of MSC is a Short Message Service Center (SMSC), which supports sending and receiving text messages. The Home Location Register (HLR) is a database used for the management of permanent data of information about mobile users authorized, Visitor Location Registers (VLRs) are databases of the service area visited by an MS (3).

Android Platform

Android is a platform introduced in 2007 for devices such as (smartphones or tablets) developed by Google that is a Linux based operating system and the open source code designed for touch screen mobile device. The applications was developed in the Java language allows the software to be free modified using the Android Studio software development kit (SDK), the SDK contains a comprehensive set of software libraries supported integrated development environment (IDE), the Android Studio (Android 7.0) to get the Cell ID, LAC, MMC, MNC, IMEI and SSN of an Android mobile, the database (SQLite) used to store this Cell ID, LAC, MMC, MNC values into periodical processes are running as background process by applying Android service, Google Maps get from web service the latitude and longitude in the format of a JSON (Java Script Object Notation) file, the Android mobile support from both Google Maps and third-party developers (remotely connect to a MySQL database) (13).

1. Web Service

A web service is a software designed to support communication between mobile application and remote server and location API over a network. The web service designed to provide compute location information results in obtaining specific geographic regions (latitude and longitude) after connected with location API according to request by the users; the web service used an online portal developed in a PHP is an open source general, the web services send and receive data with insert/delete, web service performs the tasks and generates output in the JSON format (14):

[{"gsmlatitude":"33.24567","gsmlongitude":"44.36 2478","datetime":"2017/12/22 17:17:26"},
{"gsmlatitude":"33.245621","gsmlongitude":"44.36 2425","datetime":"2017/12/22 17:22:12"},
{"gsmlatitude":"33.245621","gsmlongitude":"44.36 2425","datetime":"2017/12/22 17:28:36"},
{"gsmlatitude":"33.249792","gsmlongitude":"44.35 8406","datetime":"2017/12/22 17:33:19"},
{"gsmlatitude":"33.249792","gsmlongitude":"44.35 8406","datetime":"2017/12/22 17:38:55"}]

Representational state transfer (REST) is an architectural style for developing web services and takes advantage of the technologies and protocols of the World Wide Web, the create connected between the smartphones and remote server by volley technique proposed by Google 2013, The scheme uses POST and JSON format to transfer data (15).

Proposed tracking system

In order to implement mobile tracking system with using GSM/UMTS network of

detection mobile location for places visited through your phone, the mobile device tracking while connection with the tower BTS and stored location information (Cell ID, LAC, MCC, MNC) continuously each specific period (5 minutes) in SQLite Database. All these processes run as background by applying Android service which without suspect by mobile user. Other time for when mobile connected with internet can retrieve location information from SQLite Database of the mobile device, the location information transfer into the remote server during synchronizing between SQLite and MySQL. The server uses PHP and MySQL and can get all the necessary data to locate the phone. The PHP file will compute (latitude and longitude) for location information that stored in MySQL during creates connections with location API to obtain the locations visited during mobile device and stored the results in MySQL. The data (latitude and longitude) is then transferred to the mobile device in the form of the JSON format and use Google Maps will plot the locations. Fig. 2 shows tracking system.

In this section we propose tracking system algorithm to develop models of the relationship between the mobile application and server site. The proposed algorithm can be implemented in six steps, which are described in algorithm (1).

Algorithm 1. Description of the tracking system:

Step 1: The mobile device can read the location information (Cell ID, LAC, MCC, MNC) using cellular network (GSM/UMTS) every 5 minutes. The location information, IMEI, SSN and current date&time were stored in the SQLite database every 5 minutes. Note IMEI, SSN and current date&time can be obtained from the mobile device.

Step 2: Always have 100 records inside the SQLite Database to maintain the storage space of the mobile device. In case of addition, the first field is deleted to guarantee non-exceeded100 fields.

Step 3: Transfer location information, IMEI, SSN and date&time from SQLite into remote database MySQL using Volley technologies and web services, the server has received (IMEI, SSN, Cell ID, LAC, MNC, MCC) via POST.

Step 4: The web services provided communication between MySQL and the location API, the location information is transferred into a location API for obtaining latitude and longitude each record, the link location API is using URL= http://us1.unwiredlabs.com/process.php to obtain the longitude and latitude.

Step 5: The results stored longitude and latitude received from the location API in the MySQL database and create a JSON file.

Step 6: Through the mobile application, the data location is queried from the external database MySQL and received in the form of the JSON file format, the results are using JSON parser to display the location on Google Maps.

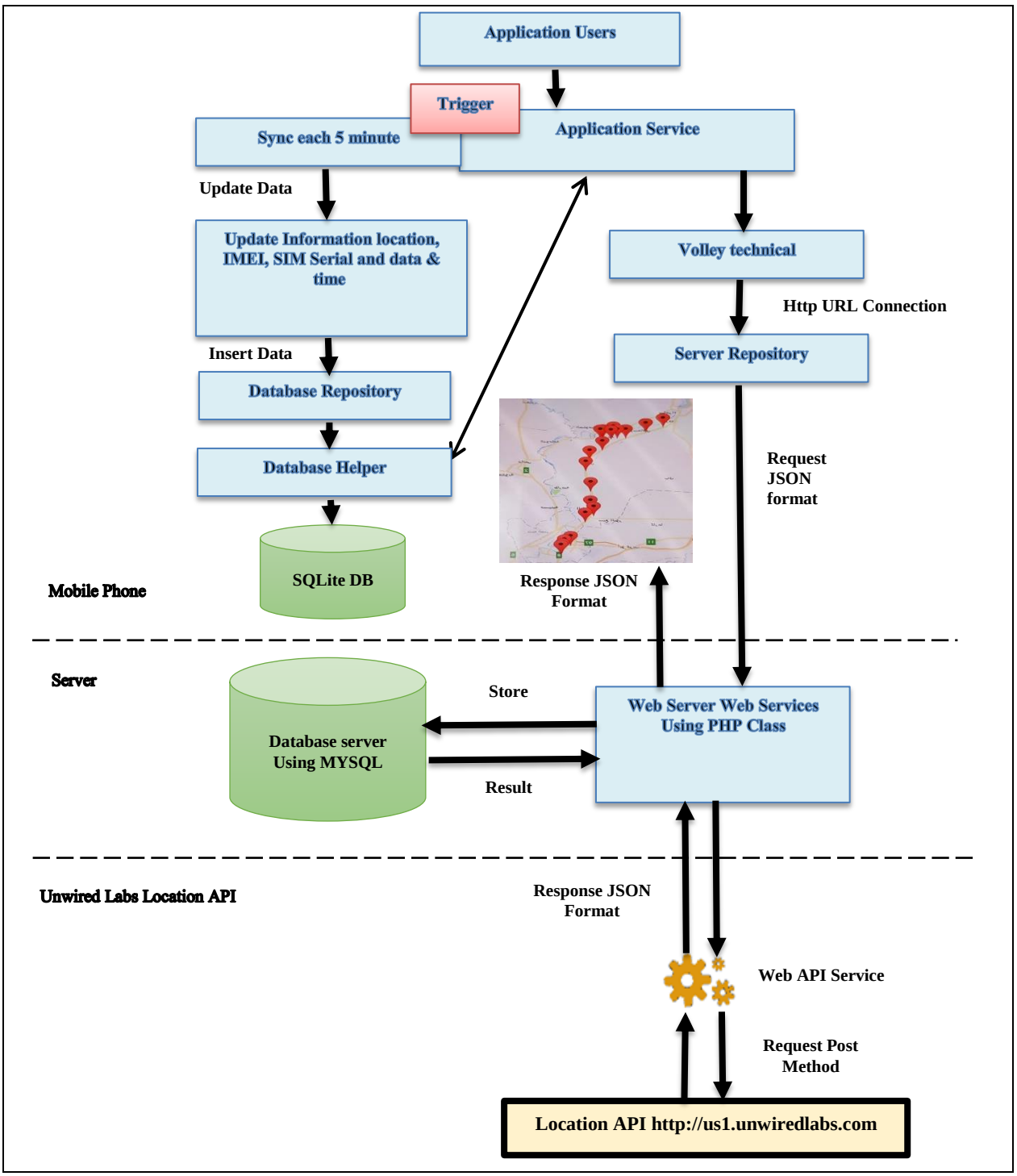


Figure 2. Proposed Tracking System.

The tracking system can be separated into two parts which are mobile application and server site.

- Mobile application

The Android mobile application obtained IMEI, SSN, current location information (Cell ID, LAC, MNC, MCC) in the four parameters in Fig. 3 shows, the four parameters considered the basic for can be found latitude and longitude.

Figure 3. Display current location information

These application processes are run in a background service using the Android service. This allows it to run operations without affecting your user so that it can continue to update current location information of the four parameters at specific intervals and periodically for a particular time to be designated by request service while device users move around towers of the mobile phone. After getting four parameters can store in the internal storage SQLite database with IMEI number, SIM card serial number, current date and time, work continues in the storage inside SQLite Even if the device becomes a screen off and without the need to connect the mobile to the Internet in Fig. 4 shows sequence diagram Mobile tracking.

The SQLite database storage maximum 100 record even not to affect the storage capacity of the mobile device with the increasing data stored, in case the record number inside SQLite database exceeds 100 records, the application deletes the first record and adds the current record at the end of the table, after connecting to the Internet the mobile device can synchronize data between SQLite and MySQL using JSON format as intermediate.

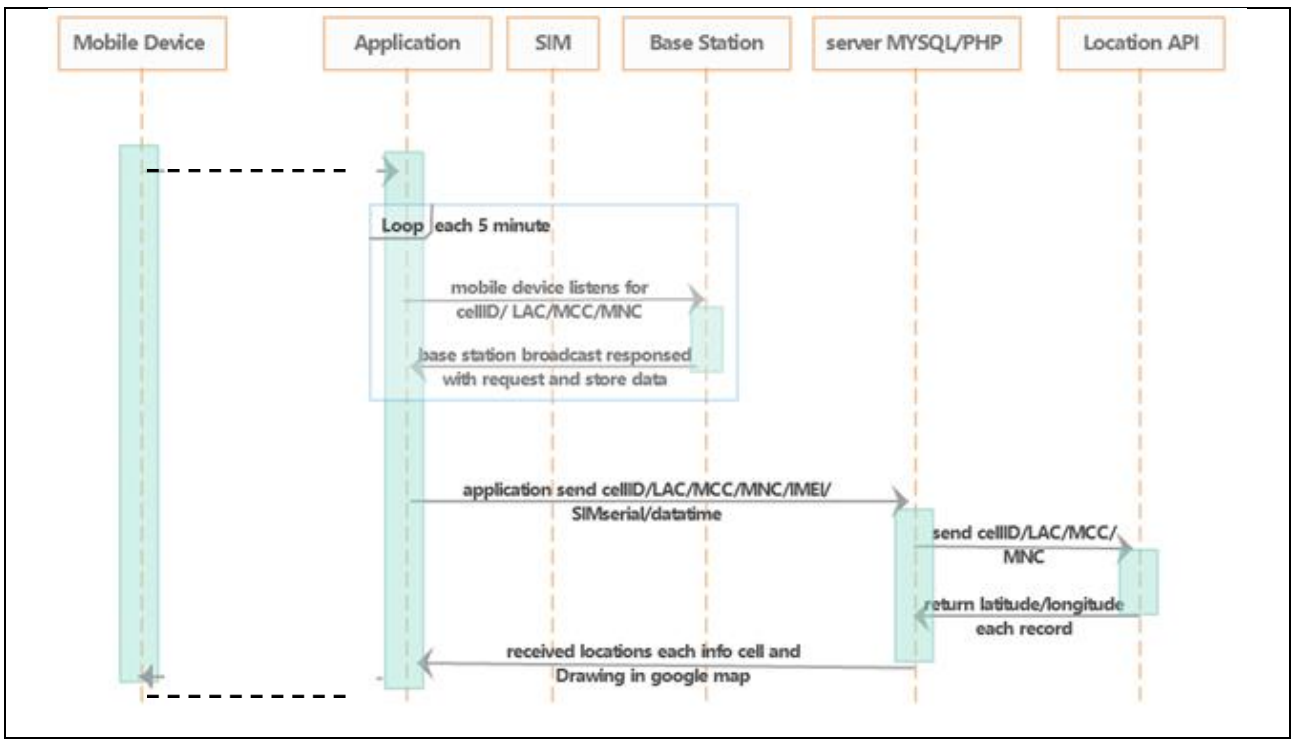


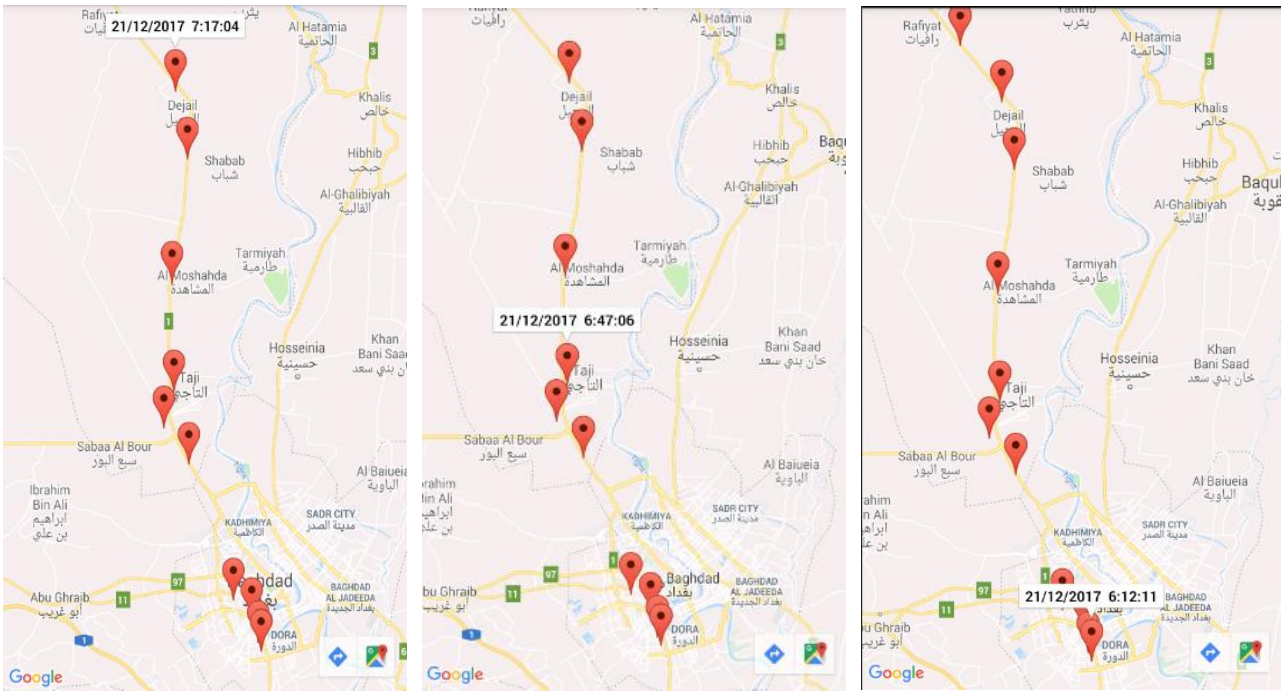
Figure 4. Sequence diagram Mobile tracking using GSM/UMTS

- Server site

The server side includes scripting language to be embedded into a PHP source document and MySQL used the open source relational database management system. After transferring four parameters to MySQL, create connected between database MYSQL and location API site http://us1.unwiredlabs.com so retrieved latitude/longitude from four parameters in all record and the output stored in MySQL database. For all records in the table of a specified device by IMEI number, after this send data into Android mobile application as JSON format.

Results:

We have successfully implemented application Android of mobile tracking system by using GSM/UMTS network, those results during the experiment, the application was run in 21/12/2017 on the way from Baghdad to Samarra the location information was recorded every five minutes, that can find the nearest position visited, the mobile was not connected with internet. some results were shown in Fig. 5. The results we see after calculation latitude and longitude depending on the location information of the GSM/UMTS network are described in Table (1).



(a) **(b)** **(c)**

Figure 5. Display result in Google Maps (a) when click first marker display data & time. (b) Click middle marker display title. (c) Click last marker display title marker data and time.

Table 1. compute latitude and longitude from basis parameters

id	MCC	MNC	LAC	Cell ID	IMEI	Sim serial	date time	latitude	Longitude
855	418	05	14003	19945606	359435058919189	8996405440003317062	21/12/2017 6:12:11	33.245665	44.362809
856	418	05	14003	19945609	359435058919189	8996405440003317062	21/12/2017 6:17:04	33.245144	44.362708
857	418	05	14003	19949440	359435058919189	8996405440003317062	21/12/2017 6:22:47	33.254439	44.358063
858	418	05	14003	19943755	359435058919189	8996405440003317062	21/12/2017 6:27:52	33.279606	44.349513
859	418	05	14002	19946338	359435058919189	8996405440003317062	21/12/2017 6:32:37	33.30084	44.323802
860	418	05	14008	19807215	359435058919189	8996405440003317062	21/12/2017 6:37:24	33.449417	44.261456
861	418	05	14008	19807215	359435058919189	8996405440003317062	21/12/2017 6:42:22	33.44942	44.26146
862	418	05	14008	19813445	359435058919189	8996405440003317062	21/12/2017 6:47:06	33.489079	44.226421
863	418	05	14008	19820716	359435058919189	8996405440003317062	21/12/2017 6:52:41	33.52829	44.240307
864	418	05	7096	50555	359435058919189	8996405440003317062	21/12/2017 6:57:28	33.647154	44.237929
865	418	05	7096	53415	359435058919189	8996405440003317062	21/12/2017 7:02:37	33.782224	44.259622
866	418	05	7096	53415	359435058919189	8996405440003317062	21/12/2017 7:07:24	33.782224	44.259622
867	418	05	7096	53415	359435058919189	8996405440003317062	21/12/2017 7:12:11	33.782224	44.259622
868	418	05	7096	51317	359435058919189	8996405440003317062	21/12/2017 7:17:04	33.855946	44.242762

The application updates the location information can also cause heavy battery consumption, this can be lowered to achieve better battery efficiency, the location information updates every 5 minutes the interval at which the current location is updated. Table (2) illustrates the different intervals that can affect battery life. the work creates new opportunities to perform tracking on remote servers, using the mobile device only to capture the location information and display the output results. The volley technology provided a good communication infrastructure to transfer the data to the remote server and vice versa. In case I have 25 requests transfer the data between the mobile device and the remote server, compare a sync task and volley technology, a sync discussion 13.957 milliseconds and the volley discussion 4.275 milliseconds. Some tracking application depended on GPS, there exist situations where GPS is not available, the solution is to combine the GPS measured values with measured values from the GSM/UMTS. This work provides proactive services which automatically tell their users when they enter or leave the bounds of pre-defined points of interest such as application Tammini from Zain.

Table 2. Compute Frequency Update Intervals

Time Interval	Details
Every 5 Seconds	This provides heavy consumption of battery power.
Every 1 minutes	This is the default setting, provides a better battery power.
Every 30 minutes	This provides better battery efficiency.

Conclusion and Suggestion

The application showed a low-cost tracking system using GSM/UMTS network, suitable for the worked all over the world with the combination of the Android mobile phone and web services. The overhead is much lower compared to average battery consumption and the application successfully tracks mobile across a single sensing. We demonstrated tracking using cheap hardware with open source projects and showed mapping techniques with cell tower databases to take advantage tracking mobile device. Finally proposed location accuracy improvement by using GSM/UMTS tracking that could be implemented without connected to API location thus using external geographical information and achieve the best performance for mobile dynamic location with Kalman Filters.

Conflicts of Interest: None.

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تحديد الموقع الجغرافي للهواتف Android المحمولة باستخدام GSM/UMTS

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الخلاصة:

انتشار الشبكات الخلوية سمحت للمستخدمين بتتبع اجهزة الهواتف النقالة من خلال أدوات تحديد المواقع المختلفة، حيث يتم التقاط معلومات الموقع بشكل مستمر من الهاتف بالاعتماد على (GSM) و (UMTS). هذا البحث يعرض تطبيقاً على نظام الاندرويد يوفر بيانات الموقع ويتم تنفيذ هذه العمليات في الخلفية. التطبيق المقترح يرتبط مع remote server ويستخدم لتتبع الهاتف الذكي دون الصلاحيات ودون الاتصال بالانترنت. جهاز الموبايل يخزن معلومات الموقع في قاعدة البيانات داخلية (SQLite) وبعد ذلك ينقلها الى قاعدة بيانات خارجية (MySQL Database) ثم تتحول البيانات إلى location API للحصول على احداثيات المواقع والنتائج تعرض في Google Maps. تتبع الهاتف الذكي مع المعرّفات ثابتة: الرقم التسلسلي لهوية المشترك (SIM) (SSN) والهوية الدولية للمعدات المتنقلة (IMEI) المشتقة من سلسلة تعريف فريدة لجهاز المستخدم. والنتيجة موقع الذي تم ايجاده ويكون صحيح الاعتدال وفقا للشبكات الخلوية المتنقلة (GSM/UMTS).

الكلمات المفتاحية: GSM/UMTS، التتبع، جهاز محمول، خدمات الويب، MySQL.