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Sensors Compatibility Requirements for Location Based Services

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Abstract—*Compatibility requirements are among the most important factors for selecting sensors to be used in Location Based Service (LBS) systems, especially in the Risk Reduction Management field. Sensors' networks use several protocols to send its signals to system remote servers. Internet protocols-based sensors are widely used. While, there is no framework to connect dialup sensors with LBS' remote servers. In order to improve the sensors' compatibility, this paper provides a framework to be employed for different sensors' communication types. This framework is a part of the proposed LBS approach for auto sending messages to the closest people of the risks.*

Keywords— *Location based services, Machine-to-Machine auto interaction. Mobile phone in risk reduction management, Real-time information, Wireless communications, Dialup sensors.*

I. Introduction

This Location-based Services (LBS) are crucial for life saving. LBS are the information which obtained by mobile devices and use the geographical location information of this mobile [1]. One of the important fields which LBS involved in is the Risk Reduction Management (RRM) [2]. RRM has 6 phases: Preparedness, Prevention, Mitigation, Response, Recovery and Reconstruction [3]. LBS involved in all RRM phases. Huge efforts have been made to deliver information to the audience through their mobile phones in risk situations [4]. These efforts include diverse application areas such as communication development, GIS tools and applications. Sensors networks usually installed in the preparation phase of RRM systems [5].

Network sensing systems are successfully used in warning dissemination to minimize the impact of unawareness people about the risky areas near them and supply them with the vital information and Instructions to follow in real time [6]. Technological advances, especially in sensors' communication and mobile devices, have fuelled the increase of LBS adoption. However, the requirements for developing LBS applications with varied types of sensors represent a new challenge [7].

Dialup sensors are facing a challenge to transfer data to the disaster or risk management servers [8]. Although they heavily-used in many kinds of risk detection. However, there is no framework to connect dialup sensors and Internet protocols-based sensors together with same LBS remote server, In order to improve the sensors' compatibility of the produced LBS system, current paper presents a proposed framework to receive incoming signals from any kind of sensors, to be usable in the proposed LBS approach for auto sending messages to nearby mobile holders at risk locations.

This paper is organized as follows: section II presents sensors' communication protocols, section III Shows the problem definition, in Section IV related works are discussed, section V illustrates proposed framework, and finally the paper conclusion is presented in section VI.

II. Sensors Communication Protocols

LBS systems use a large number of sensors of different types and purposes especially in RRM field, including fire, smoke, temperature, lightning, humidity, gases, radiation and more. Once the sensor has been exploited in the system, it must be able to autonomously adapt itself into the system's communication network. The most important issue for sensors' networks is its compatibility.

Since the sensors' networks are relying on several protocols. This means that, besides the sensors and other hardware, the used communication protocols and standards on different types are of high relevancy. Sensors' communication protocols used in the development of sensor based systems are:

Internet Protocols:

The communication between internet-based sensors and remote servers uses the web services protocol, which is the Simple Object Access Protocol (SOAP), it transfers the data packets through (HTTP, TCP, IP, ZigBee, and Neul) [9]. Address Resolution Protocol (ARP) is the mapping of the sensor (internet-device) IP address to its MAC address [10].

Cellular or Dialup Protocols:

Standards: CDMA, GSM, GPRS, 2G, UMTS/HSPA (3G), LTE (4G), they are used for any application required for long distance communication, their Frequencies are: 900/1800/1900/2100MHz [11].

TCP/IP networking over point-to-point protocol (PPP) is a serial communication links protocol (SLIP), which is the most used in dialup connections. There are two popular protocols for TCP/IP networking over point-to-point serial communication links: chap and pap protocols [12]. Each GSM Device or CDMA device has its associated subscriber phone number [13].

III. Problem Definition

Non-homogeneous of sensors' connection types represents a serious obstacle for data handling applications and its value extraction. LBS risk management systems need to be smarter, which means that there is a need for specific approaches to make any LBS' sensor compatible within the LBS system.

This paper presents a proposed framework that will increase the sensors' usability and compatibility in the proposed LBS system, to help in the effective management of emergencies which depends on timely information availability, reliability and intelligibility.

IV. RELATED WORKS

Many efforts have been made to alert people during the of risk occurrence using the sensor systems. Here are some examples:

a) Singapore Lightning risk alerting system: deployed to send SMS messages to citizens.
b) New Zealand Warning system for impending disasters: this system provides mobile users who located in risky areas a set of free live updated SMS about current emergencies include lahars, major flooding, tsunami, or other natural or man-made disasters.
c) Satellite-based alert systems: Both Japan and South Korea have launched a satellite-based alert system. The system provides both countries' citizens with SMS of natural disasters, and operates sirens and voice alarms.
d) EVigilo system was installed in Chile in 2012, this software gets signals from earthquake sensors, decides which areas are under threat and issues mass alerts within the danger zone.
e) Earthquake and Tsunami early Warning System (ETWS) in Japan: this system disseminates warnings over television and radio, based on Cell Broadcast Services (CBS) technologies [14].

V. PROPOSED FRAMEWORK

The proposed framework is a part of a new approach for automatically deliver notifications to the closest audience of risky places. This framework is proposed to ensure that the sensors are compatibly connected to the LBS' remote server, to establish sending predefined alerts to the closest people of the sensor's location when this sensor switched to be active.
LBS have many classifications such as system user interaction classification and used technology classification, the proposed approached could be considered as:

From system user interaction point of view: the proposed approach could be considered as a proactive interaction system, it provides important information to the mobile owner once he/she inters the targeted fence and in the time of event occurrence as a machine to machine interaction communication using the device internet (as IOT solution).

From a technology point of view: The proposed approach could be considered as a sensor based, and depends on GPS technology with device internet technology to determine the current location of the mobile holders [15].

The new approach uses sensors such as fire, smoke detectors or any other alerting physical sensors, which able be connect with the remote server when the accident occurs [Table 1] displays the approach components.

The software architecture for this approach comprises three main components, [Fig. 1] illustrates proposed approached components, the mobile application (Android in this case study) for sending mobile handset's coordinates (Latitude, Longitude) and it's updates to SQL database created on public remote server, and to receive the notification from the public server if the current mobile coordinates located in the affected sensor's region. The second component is an admin/client Web Interface (ASP.NET application) which has 4 features, presented through Graphical User Interface (GUI) which covers almost all the functional requirements for either the content provider (system admin), or the client module (which presents the data of affected sensors to police stations, ambulance and civil defense).

TABLE 1. Proposed system components.

Component	Implementation Technology
Sensors	Alarms detectors, Sensors
Mobile application	Android
Back-end Server	Remote server
Admin/Client Web App	MS VB. NET
Sensors connection framework	MS VB. NET
Database	MS SQL Server

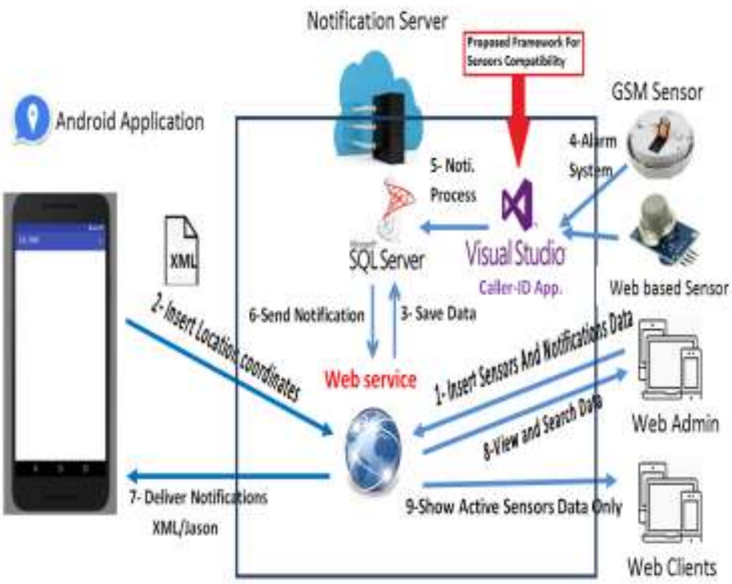


Fig. 1. Proposed approached components.

The third part of software architecture for this approach is the proposed framework for sensor's communication which guaranteed its compatibility. This framework uses the ARP protocol for receiving the Sensor's MAC address for internet-based sensors. While acting as a caller-Id software to receive the cellular or dialup (GSM or land line) phone number assigned to the sensor which uses dialup either land line or cellular (GSM) connection. The sensors' MAC addresses which assigned to the internet-based sensors, and the phone numbers which assigned to dialup sensors are stored by the system admin into the database which published to the risk notification remote server, in "sensor's data" table.
The proposed approach process scenario:

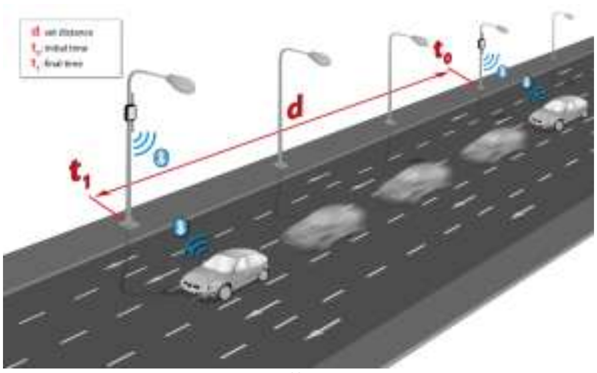
The process of using the android application, the web interface (admin/client), and the proposed frame work for sensors' connection are described in the following scenario:

Sensors instalment and configuration:

- The proposed frame work allows the possibility of using a sensor of any type of communication either internet-based sensors, or the sensors which use the dialup connection. The candidate sensors are all kinds of detectors and sensors which are already installed in schools, colleges, clubs, hospitals, factories, firms, organizations, government offices bus station, train stations, and any other of hustle places. [Fig. 2] presents some types of sensors communication.

Cellular Smoke detector sensor

Network IP Gas detector sensor



WiFi traffic sensors

Fig. 2. Examples of risk sensors types.

- If the installed sensor is a dialup sensor, the system admin uses the sensor's controller to insert the remote server's phone number [Fig. 3] displays the dialup either land line or GSM Sensor's controller.
- If the installed sensor is a network sensor, the system admin uses the sensor's controller to insert the remote server public IP address.

Fig. 3. Dialup or GSM sensor controller.

Storing sensors 'data and its corresponding messages:

Fig. 4 illustrates the web admin application home page with the four feathers:

"Sensor" button to enter the required data for the new sensor which may be either internet-based or dialup-based sensor.

"Notification" button for entering the predefined notification that will be assigned to this sensor.

"Track phone" button to present the last updated location data which stored in the remote server for the inquirer specific mobile number that captured by the android application. This feature will be useful in many other fields such as in chilled tracking, rape crimes, and anti-terrorism.

Finally, "Active Sensor" button to show the current active sensors' data and its spatial attributes. This feature for displaying the essential data for the active sensors in the web client version, this version is proposed to be installed for police stations, ambulance and civil defense, for immediately tacking the need action against the sensed risk.

These two modules of the web application (admin/client) are published on the remote server and can be accessed through mobile phones, PCs, laptops, tablets or any device with internet access.

Fig. 4. Admin web application.

Storing Sensor Data:

- System admin can uses Google-Maps (or any other solution) to get the current coordinates of the sensor.
- He/she can uses the admin web application GUI to insert the new sensors' data (latitude, longitude, sensor's location full address, alternative best-paths for ambulance and police vehicles) into SQL data base which on the remote server in "Sensor_Data" table, in addition, system admin should insert the following connection data:
  -The SIM card phone number or the assigned land line phone number (in case of using a dialup sensor).
  -The sensor device MAC address if it is internet-based sensor [Fig. 5] illustrates the required sensor's data.

Fig. 5. Adding new sensor data to the remote server.

Creating a new Notification

- System admin uses the Notification page in the admin web application GUI [Fig. 6] to insert the notification or alert for this sensor, (he/she can choose sensor's phone number if it is a dialup sensor, or its assigned MAC if it is an internet-based sensor) and write the notification text related to this sensor to be sent in its active statue).
- He/she can also add the public URL for a picture (could be a life snapshot) to be sent to mobile holders with the notification text.
- The inserted data will be stored in "NotificationText" table in the remote server.

Fig. 6. Adding new notification to specific sensor.

Mobile Application

The android application gets the mobile handset coordinates, (by location listener and location manager classes) and sends it to SQL database which on public Server through web service using the SOAP protocol [Fig. 7], the data will be updated by this android application every period of time or in changing of mobile location (for example it could be as every two minutes, and the distance as every 100 Meter from the current location).

The collected data from Android application are (the location longitude and latitude, the mobile Phone numbers Line1 and Line2, and the mobile MAC address), the mobile MAC address will be stored into "Android_track" table in the database.

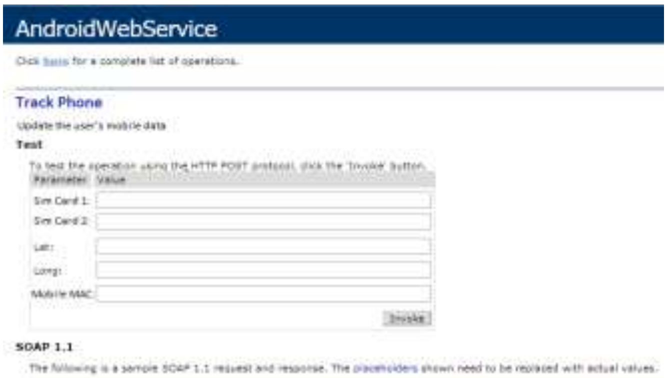


Fig. 7. Web service used to update the mobile data into the data base on the remote server.

Notification Delivery

When the risk event is occurred (fire, smoke, high traffic, or any other sensed event), the installed sensor will be switched to the active statue, and establishes the connection to remote server, through the proposed framework as follows:

- In case of the infected is a network sensor using remote server IP address in communication, it will send message packets to the remote server, the proposed framework will receive it through ARP protocol as an ARP request [Fig 8].

The frame work obtains the sensor's device MAC address from the ARP request and starts a match query between incoming MAC address and the sensors' data which in the "sensor_data" table, the results will be inserted into "active_sensors" table on the remote server database.

- In case of the infected is dialup-based sensor using GSM or Land Line phone number in communication, it will send a ringing call to the remote server, which receive it through proposed framework [Fig. 9], the framework establishes the connection receiving through the PPP spiral link protocol, the framework gets the incoming dialed phone number, starts a match query between incoming phone number and the sensors' data which in the "sensor_data" table, the results will be inserted into "active_sensors" table on the remote server database.

```
Microsoft Windows [Version 6.1.7601]
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C:\Users\Ashrafalzab>arp -a
Interface: 172.16.1.120 --- 0xb
  Internet Address      Physical Address      Type
  169.254.40.64         cc-ef-48-0e-0b-29     dynamic
  169.254.46.250        cc-ef-48-0e-0b-29     dynamic
  169.254.73.199        cc-ef-48-0e-0b-29     dynamic
  172.16.1.1            cc-ef-48-0e-0b-29     dynamic
  172.16.1.3            ec-a8-6b-68-e4-5f     dynamic
  172.16.1.4            98-be-94-2b-9f-42     dynamic
  172.16.1.5            98-be-94-2b-9f-44     dynamic
  172.16.1.7            54-9f-35-02-30-0e     dynamic
  172.16.1.8            00-1e-4f-20-a0-47     dynamic
  172.16.1.9            98-90-96-b1-60-89     dynamic
  172.16.1.10           00-d0-b8-1b-bd-57     dynamic
  172.16.1.125          ec-a8-6b-68-df-f3     dynamic
  172.16.1.126          ec-a8-6b-68-e0-19     dynamic
  172.16.1.133          fc-45-96-56-fd-07     dynamic
  172.16.1.134          00-1f-d0-01-ed-02     dynamic
  172.16.1.137          20-89-84-42-49-81     dynamic
  172.16.1.254          68-ef-bd-19-93-e1     dynamic
  172.16.1.255          ff-ff-ff-ff-ff-ff     static
  224.0.0.2             01-00-5e-00-00-02     static
  224.0.0.22            01-00-5e-00-00-16     static
  224.0.0.251           01-00-5e-00-00-fb     static
  224.0.0.252           01-00-5e-00-00-fc     static
  239.255.255.250       01-00-5e-7f-ff-fa     static
  255.255.255.255       ff-ff-ff-ff-ff-ff     static

C:\Users\Ashrafalzab>
```

Fig. 8. ARP protocol request command on remote Server.

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Fig. 9. Proposed Framework

Proposed Framework receives sensors dialup numbers or sensor mac address and inserts it into (active_sensor table) on remote server database.

The webservice while receiving the updated data each 2 minutes from android application to insert it into “Android_track” table, it starts a SQL match query between “Android_track”, “Active_sensors”, and “NotificationText” tables, if the mobile location within the range (+) or (-) 500M of the active sensor’s location, the resulted data will be inserted into “Active_users” table. The “Active_users” table includes the mobiles MAC addresses of all mobile users whose their location within the range, and the assigned notification for this active sensor from “NotificationText” table. Then, the webservice will use the SOAP protocol to deliver this notification text attaché with the image’s URL to be displayed immediately on the android application Screen.

Fig. 10. Mobile received a notification text with an image.

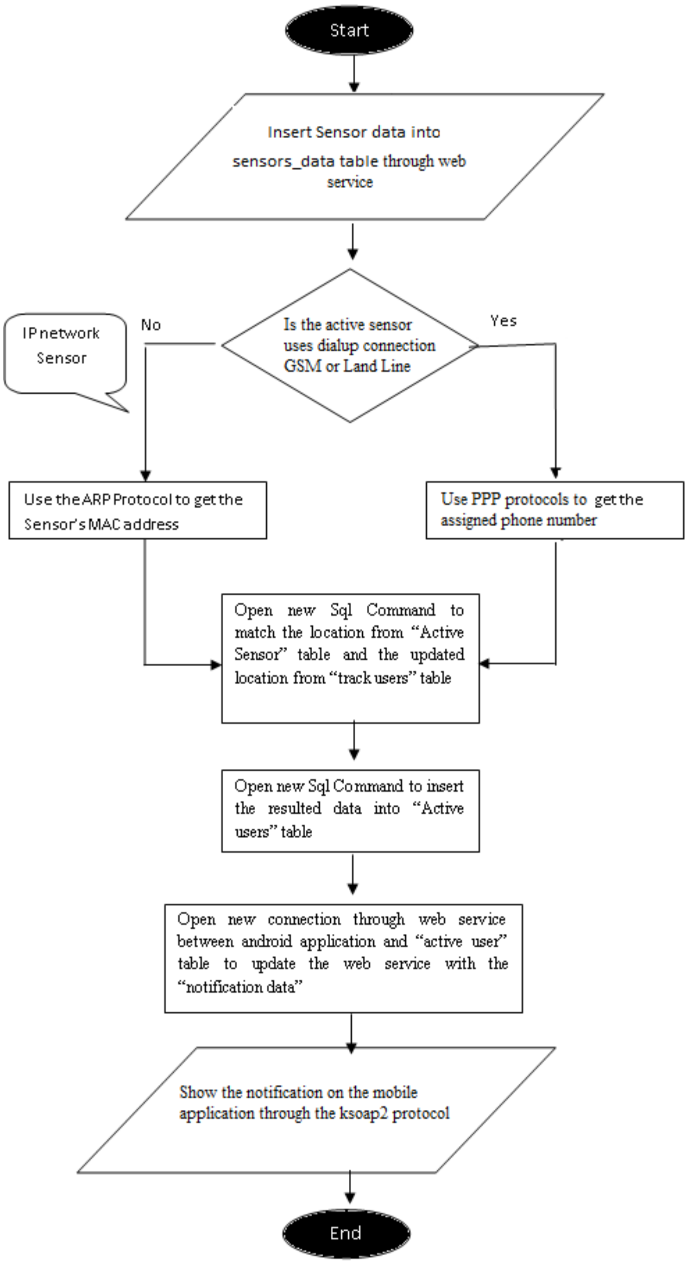

Fig. 11. Framework flowchart.

VI. CONCLUSION

This paper describes a new framework for using different types of risk detection sensors to address the compatibility requirements in LBS systems. The proposed framework designed to receive different kinds of communication protocols, either through the ARP protocol for internet-based sensors, or PPP protocols to get the dialup phone number for sensor which uses dialup protocols such as CDMA, GSM, GPRS, 2G, UMTS/HSPA (3G), LTE (4G) or PPP protocols through Serial Link for dialup-based sensors. The framework is a part of the new approach for auto sending location based messages by using physical sensors which are connected to remote server, this server collects the user’s location updated from the android system, and pushes the predefined message if the mobile holder located in active sensors region. The targeted area will be determined by The GIS algorithm for calculating the distance between two points (the active sensor and the mobile locations).

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