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M2M Emergency Help Alert Mobile Cloud Architecture

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***Abstract*—Emergency situations are unfortunately part of our lives. Today's smart computing allow us handle such situations and fulfill our requirements more efficiently and effectively. This paper presents architecture to handle various kinds of emergency situations more efficiently and effectively, by allowing the user (victim or witness) easy and quick way to alert the concerned department(s) with just a single button press. The service automatically sends the location of incident and contacts the appropriate emergency dealing department automatically through already stored contact numbers. The emergency related information is then synchronized automatically to the mobile cloud, allowing further analysis and improvement in safety of people and creates further services for the concerned authorities and users. Performance in most certain scenarios is also evaluated and presented in this study.**

***Keywords*— M2M; mobile cloud computing; emergency alert**

I. INTRODUCTION

A situation that poses an immediate risk to health, life, property, or environment, is known as emergency situation. Emergency situations are part of our lives. They can happen at any moment, any place, to anybody. May it be an accident, a fire breaking out, building being collapsed, murder, robbery or kidnapping, stealing or damaging something, or an act of terrorism; any kind of such situation can arise. With the increasing number of such situations, in today's age of smart phones, it has become necessary to have a solution for quick and easy way of alerting the right people for help and inform family members in an efficient and easy way. With the advent of cloud computing, mobile cloud computing, and smart phones, it has become very important to use these paradigms for such purpose more effectively [1], [2], [3], [5], and [6].

Currently, the way emergency situations are tackled at the user's end, is not efficient at all [2], [3]. If any emergency situation occurs, the victim or witness has to first decide the type of emergency and then find out which appropriate departments have to be contacted. For example, in case of an accident, the victim or a witness has to call ambulance, as well as the police. Hence, manually finding out the contact numbers and departments is not efficient at all, specially when there is a panic situation. After that, the victim or witness will inform his/her family members, may it be one, two, three or even more. All this is time taking and in case of emergency, very frustrating and can cost life as well. All this traditional process is shown through a flowchart in figure 1.

Although, there have been a lot of work in this regard, but current solutions do not counter this issue in an efficient and simple way. In this paper, we present an architecture and service to tackle different kinds of emergency situations in a very simple and efficient way. User is only required to take single action, which is a button-press, which triggers the service to inform appropriate departments automatically, including sending the location of event, and also inform the family members of the affected person.

In rest of the paper, section II is on already done work, while, section III discusses Machine to Machine (M2M) communication. Section IV is on our proposed system. We evaluate and discuss the results of our system in section V. Our paper concludes in section VI.

II. RELATED WORK

Studies have been done on emergency related issues, some of which are presented here. Kathy Pretz [8] states the usefulness of social media, specially Twitter, for emergency notifications. It is stated that Twitter provides a new source of data from which awareness about developing situation can be obtained. The prototype developed uses data-mining techniques to harvest high-volume Twitter streams and identify early indicators of an incident. It can further explore the impact of disaster and monitor its evolution. The prototype developed is deployed in Australia. Using a data-capture module, the program continuously collects and analyzes tweets from

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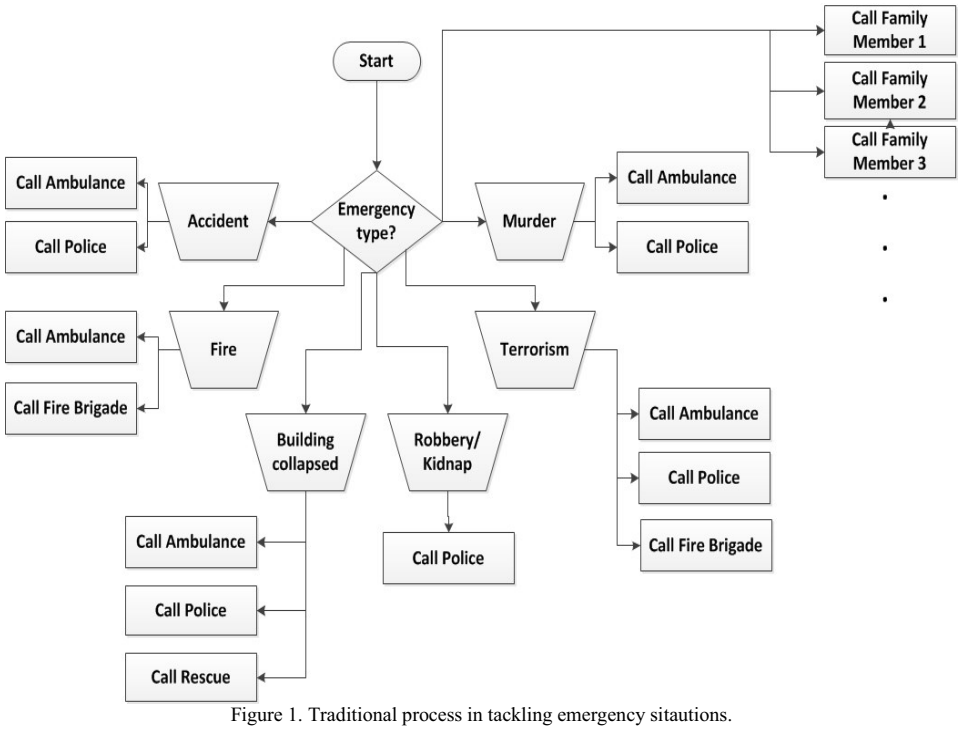

Figure 1. Traditional process in tackling emergency sitautions.

locations throughout Australia. It relies on Twitter's location-based search and automatic processing interface, handy software tools, and a near-real-time search interface. According to the author, Twitter is being used increasingly by people; hence, it would be easier to report an incident and to report what is happening, who needs help, and the extent of damage. One issue is that when a disaster strikes, the volume of tweets can be overwhelming to be monitored and the useful data to be extracted. Also, it totally depends upon those who use Twitter. Even in the countries where there is very high literacy rate, not everyone uses social media. Overall, users of Twitter would then be very few. Likewise, this mechanism has to deal with a large amount of tweets and complex algorithms to take out what is needed. Instead, a more efficient way, which can be more prevailing not only in Australia, but in the rest of the world, specially under-developed countries, should be introduced. At the time of emergency, the first priority should be to alert the concerned crisis dealing department in a more efficient, easier, and accurate way, which should be simple for an illiterate person as well.

Jie Yin et al. [9] discuss on the same theme as discussed above. The authors describe a system that uses natural language processing and data mining techniques to extract situation awareness information from Twitter messages generated during various disasters and crises. System architecture is presented for leveraging social media to enhance emergency notifications. The data sources in this system are high-speed text streams retrieved from Twitter during the incidents. The text streams provide situation awareness information, such as community responses to emergency warnings, near-real-time notification of incidents, and first-hand reports of an incident's impact. Again, it all depends upon how efficiently and effectively the information is retrieved and made useful. The rest of the issues in this study are the same as discussed for the study [8].

Hannes Tschofenig et al. [10] propose IP-based emergency service. Keeping in view the importance of this topic, the Internet Engineering Task Force (IETF) has identified this requirement and created a working group named as Emergency Context Resolution using Internet Technologies (ECRIT) IETF GEOPRIV Working Group[1]. This working group focuses on protocols and techniques to develop a robust emergency architecture which can serve all forms of IP-based networks. For emergency situation notification and to make emergency call, the caller needs to acquire location information, the end systems or proxies need to identify an emergency call, marking and routing it to the proper Public Safety Answering Point (PSAP). However, there are some variants of the basic operation based on the deployment scenarios. For instance, either an end host or a proxy may have to determine the end host's location, either the end host or a Session Initiation Protocol (SIP) proxy performs the initial location-based routing (i.e., the mapping of location information and emergency service identifier to PSAP URI) and the emergency call identification (including call marking) might be done either at the end host or at a SIP proxy. But this all may have to face location spoofing at some stage. One way to counter location spoofing is to let the location server sign the location information before it is sent to the target and the signed location information is verified by the location recipient rather than the target. Still, signing location

[1] https://tools.ietf.org/wg/geopriv/

information is insufficient, as it allows replay attacks. Also, emergency situation requires quick responsiveness, which this mechanism clearly lacks. This mechanism focuses only on one aspect, which is call establishment. Emergency notification requires a lot more now, keeping in view the frequency and magnitude of such situations occurring all around the world.

Qing Ye et al. [11] discusses the uncertainty attribute in emergency situations. It is stated that uncertainty is an important feature in the emergency incident management. The emergency event may happen at anytime and anyplace. Authors present finding probability of an emergency event, based on Laplace criterion. One of the main drawbacks in this study is that it is supposed that the probabilities of emergency events occurring at any point of the way are the same. Emergency vehicles deal with the emergency events through the road infrastructure network. Emergency vehicle location models aiming to a maximum coverage of the target and demand at any point in the road network are established. Therefore, the main focus of this study is on the emergency vehicle location problem. The objective of which is to be able to arrive within the specified time designated place and can cover as much of the potential demand. Other than uncertainty, there also lies the difficulty in the type and extent of emergency event. Since time is vital in emergency situations, therefore, the critical thing is that vehicles be at all time located so as to ensure an adequate coverage and a quick response time. But the problem is that it cannot be determined beforehand that what kind of emergency situation is going to take place, hence, what kind of emergency vehicles (ambulance, fire-brigade, police, rescue) should be made ready all the time. As it is a critical matter, relying on assumptions is not quite effective in this regard. The events that occur far from the main road are considered to have occurred within the reach of emergency vehicle. This assumption is also a major lacking in this study. The authors also consider that the occurrence of emergency events at any point of the way happens with the same probability.

Zhang Yunlong et al. [12] focus on environmental and atmospheric accidents only. Environmental problems, such as the atmospheric pollution accidents, water pollution accidents, and solid waste pollution accidents had become one of the most notable emergency management problems for Chinese government. In order to find the occurrence and development rules of environmental pollution and destruction accidents, forecast methods are often used. In their study, the authors use a model to analyze the environmental pollution and destruction accidents of China in past recent years. The accidents contain atmospheric pollution accidents, water pollution accidents and solid waste pollution accidents, etc. Event times are used in the model to forecast their occurrence. This study does not extend their work on the emergency situation we normally face in our daily lives.

The study discussed by Lin Dajian et al. [13] is on configuration of resources, which are to be used for judging emergency rescue process to have a balanced optimization configuration of the resources. In order to determine the levels of the emergency response capabilities in industrial accidents, it is necessary to have a balanced resource allocation, for effective rescue process. This article is mainly to overcome evaluation system from some enterprises which already exists, uncertainty factor of relevance of evaluation index system with butterfly catastrophe theory to build up four-dimensional evaluation model of the enterprise's emergency rescue capabilities. Since emergency event and its extent cannot be predicted, Emergency Resources play a very important role in emergency rescue process, because they are directly related to the accident's classification disposal of emergency plans. Emergency resources mainly include: human, machine, environment, and management. Human with some emergency training can learn emergency measures and judge potential risks involved in the accidents and the possibility of accident happening correctly and immediately. On the other hand, machine is to deal with the safety and facilities for handling emergency situations. Emergency channel, emergency equipment's type, quantity, performance and storage locations, and standby facilities are all that a machine has to deal with. Management is mainly reflected in whether you can perform the whole rescue and emergency tackling task properly and effectively. There are many factors that may affect emergency response capability of enterprises. Inductively, there are four factors that are to be focused on: human factors, equipment factors, environment factors, and management factors.

III. M2M COMMUNICATION

Machine to Machine (M2M) communication is emerging communication paradigm that is going to be an essential part of ubiquitous computing that we are heading towards. The upcoming Internet is the Internet of Things (IoT), while cloud computing; on the other hand, has also a lot to play an important role with IoT.

M2M is the direct communication of the devices and machines with the same ability. The M2M device can connect to the M2M server directly through a wide area network (WAN) connection, like 3G/4G or an M2M gateway, which is knows as aggregation point [15]. The gateway is a smart M2M device that collects and processes data from simpler M2M devices, aggregates the data, and manages the overall activity. Typically, connecting through a gateway is a preferred option, specially when devices are resource constrained, sensitive to cost, power, or location. There are several low-cost radio protocols, such as IEEE 802.11, IEEE 802.15, and power line communications, through which these devices can communicate. Many M2M applications will require connectivity between end devices. Peer-to-peer (P2P) connectivity can be supported in this architecture at various levels of hierarchy depending upon latency

requirements and the type of data that has to be communicated [16].

Total market of M2M reaches USD 70bn in 2011. Market trend, up to 2010 was in such a way:
Automotive +37%, Track and trace +87%, Vending/Point of Sale/Payment +139%, Remote monitoring +188%, Security +115% [14]. One of the usefulness of M2M with such studies is that M2M systems need to be able to detect unusual events (such as changed device location, device damage, and other related things) and support appropriate levels of authentication for M2M devices and gateways [15].

IV. Emergency Help Alert Mobile Cloud (E-HAMC) Proposed Architecture

The objective is to automatically contact the appropriate emergency tackling department as well as send message to the family members (to alert them to avoid any further problems or ask for help) upon occurrence of such events and then upload the data on cloud, for furtue analyses and other services. Proposed architecture is named as Emergency-Help Alert Mobile Cloud (E-HAMC).

Many applications have been developed to tackle emergency situations, but all of them lack some basic functionality that is very vital in critical situations [3], [4]. So far, no service is available through which appropriate emergency tackling department (e.g. fire-brigade) is directly contacted by the application, upon user's single action or click of a button, instead, the user or victim has to decide which departments have to be contacted and then find out their contact numbers. At the same time, in our system, a message is sent to the close family members (as many as user wants to) of the user. In our case, proposed E-HAMC maintains a list of those family members. With this, user does not need to find out which department to be contacted and search for contact numbers of family members at the time of emergency. User will only click on the type of event; rest of the things will be done by the application. The exact location of that even can be sent through global positioning system (GPS) or through base tranceiver station's (BTS) location, avoiding further hassle. Figure 2 shows the basic interface.

Figure 2. Basic interface of proposed E-HAMC.

As discussed, the data may be uploaded on the cloud, which helps related departments for better planning and future betterment [7]. All concerned departments will be able to access all type of incidents' information over the cloud and analyze it. For example, if some area faces more accidents at night due to bad light or sharp turns, then that issue can be tackled in future. Similarly, hospitals and ambulance service providers can see which location is more suitable to have their office or emergency vehicles' location, for quick response and have reachability to the place of event, keeping in view the frequency and types of events that occur in a particular area. In case of emergency situation, instead of thinking about whom to contact and how to contact and then inform the family members as well one by one, the user only has to select the type of event occurred through a simple user-friendly menu. Upon doing that, the application sends message to the control center of appropriate emergency dealing department by sending a short message, including the place of that event, which can be taken from the BTS the cell phone is being connected or through GPS.

Other than this, the application automatically sends message to the already stored close family members, whose list is maintained by the application. This has another benefit that if the victim is not in a situation to inform his/her family members, then any witness or passerby can do it with a single button-press using E-HAMC in his/her own phone, on victim's mobile phone. After that, the data is to be uploaded on the cloud by the application, so that concerned authorities can gather the data from the cloud, when needed, to analyze which kind of emergency situations have been rising with what frequency, in any particular area and what are the reasons. This will allow preventing and avoiding such situations in future and ensure better public life.

Communication pattern of proposed E-HAMC is shown in figure 3.

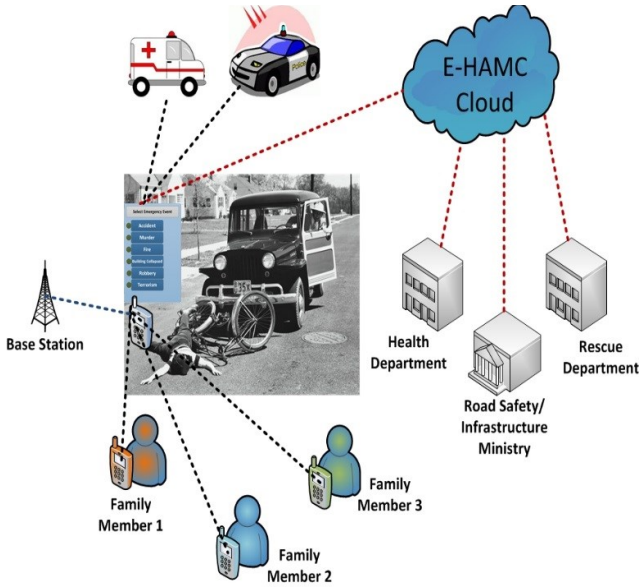

Figure 3. E-HAMC communication pattern

A. *Handling prank emergency notifications*

It has been experienced that people sometimes misuse the facility of emergency notification and give prank calls to the corresponding departments. To counter this issue, the mechanism in the proposed E-HAMC is that there is an automatic way of sending picture of the emergency area. Since this service is to be used with a smart phone, which is now available to most of the mobile phone users, there would be a camera as well in the equipment, which can do this task very easily. The application will ask to capture the snap and it sends it to the server automatically. This will ensure that there is some event occurred and the caller is not giving any fake information. Even if the victim itself is not able to do this, any passerby or helper can do this on the site of event and notify through this service.

B. *Contacts update according to user's location*

Since users are mobile and can move to any location at any time. Therefore, it is important to have the contact numbers updated of appropriate and nearest possible crisis dealing department, in the new location (which can be another city). To do this, the contacts are automatically updated through the main server or cloud application, to which the client is connected with. When the new location is another domain, not dealt by the previously stored emergency dealing department, then the client application requests the server to update new contacts, if required, and thence, user is always ready to notify automatically and does not need to worry about updating or syncing the contact details manually.

C. *Avoiding location spoofing*

Location spoofing is also another issue which we have tried to tackle in our proposed system. Linked to the prank call issue discussed previously, the caller may spoof regarding his location. In the traditional available ways of handling emergency situations, this problem occurs a lot and becomes a real headache for those who have to deal with it. Due to this kind of issue, the network is left busy and actual victims sometimes are not able to reach the rescue department. We have handled it by making location awareness automatic. When a user/victim sends emergency notification, the location is automatically taken from the GPS or BTS of the user's mobile device, it has been connected with. This mechanism makes it impossible to spoof location.

Figure 4 represents the cloud service management at the cloud site and generating further services from it, which are then used by the concerned departments.

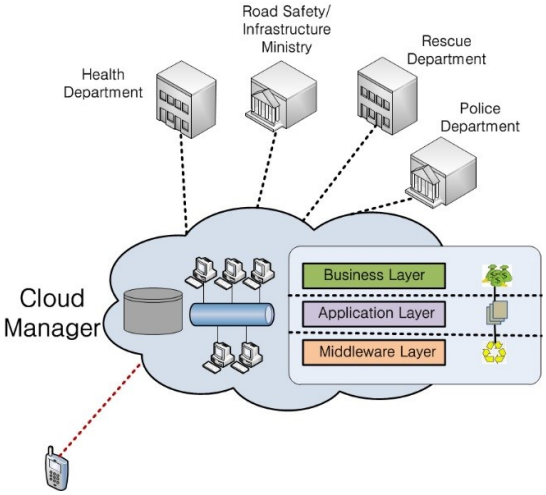

Figure 4. Cloud manager managing cloud resource allocation and services.

V. PERFORMANCE EVALUATION

In this section, to keep things comprehensive and to the point, we have covered one aspect of evaluation here. We present the performance evaluation of communication between the gateway and cloud. For this evaluation, two types of data sets were used: (a). multimedia (audio/video) file and (b). bulk-data. Multimedia file data set is used to represent the situation when an audio or video file, based on the disaster, is uploaded to the cloud. In this regard, we used 20MB file for the purpose of evaluation. Bulk-data is for the situation when images, location, text message, and other relevant data is uploaded in the cloud. For different file types, different scheduling algorithms are used by the cloud. For example, shortest-job-first, first-in-first-out, etc., which have their own impact on the overall performance of data storage in the cloud. The evaluation consists of five users in each case, who are using E-HAMC service and notify for different emergency situations to the concerned departments.

To ensure that the network condition does not affect the performance drastically, we conducted this evaluation exhaustively for six weeks, on different sets of weekdays and weekends, during different times of the days. The results were eventually averaged.

Shown in figure 5, the uploading time for a 20MB video file by five different users to the cloud. An average of 69.3 seconds duration is required to upload the stated size of video or multimedia data on the cloud.

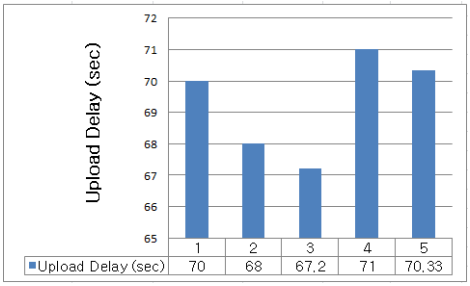

Figure 5. Upload delay from node to cloud.

In the second form of evaluation, bulk-data was used. We used up to 100MB datasets, but for simplicity sake, only 10MB bulk-dataset evaluation is shown here, which is most commonly the maximum size of bulk-data in all types of emergency events. Figure 6 shows how much multitude of files incurs delay for each of five users. average of which becomes 27.82 seconds.

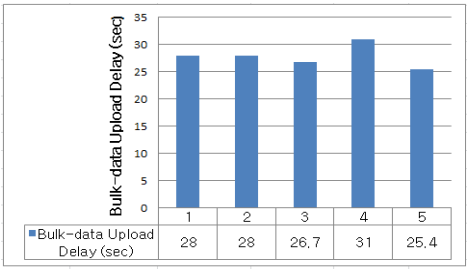

Figure 6. Bulk-data upload delay from node to cloud.

VI. CONCLUSION AND FUTURE WORK

The world is growing very fast, so are the emergency situations. Notifying for such events in a quick and easy way is becoming very important. This research activity was focused on handling emergency situations more efficiently with minimum amount of effort at the user's end and also utilizing mobile cloud computing paradigm for data and facts storage for future care, analysis, and improvements for the purpose of safety and care. Keeping in view the frequency and the extent of emergency events being occurred throughout the world, the focus of this study was to have an efficient architecture, utilizing M2M communication paradigm, cloud computing, and smart phone service to have an effective and quick way of notifying emergency incidents. Cloud computing plays a major role not only in efficient utilization of resources, but also, in generating further services, which is among the main focuses of this proposed architecture. Our presented results show the overall performance for some scenarios and validate the effectiveness of our proposed architecture. Future aspects of this study can be in terms of creating further services through cloud computing. Other than that, route mapping for the emergency dealing department can also be a good research aspect. We also want to extend our service with having multi-lingual feature.

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