EAMC: using Fog Computing and RRP for Exigency Alert Service

Deepika M, Srinivasa R

[1]PG Scholar, [2]Associate professor, Department of Computer Science, RRCE, VTU, Bengaluru, INDIA

deepikamgowda4@gmail.com , srinivasa.r@rediffmail.com

ABSTRACT-Timing is the most important factors in exigency management. Exigency notification techniques must be trouble free and quick, in order to have efficient response for any disaster, health-fix, act of terrorism, etc. In this paper, we present service architecture for exigency alert, using Fog computing cloud computing and Reliable Routing Protocol (RRP). Fog computing brings cloud resources close to the underlying devices and is used for offloading resource constrained devices and Reliable Routing Protocol (RRP) is used to maximize the reliability of data collection and control command delivery in wireless sensor networks. A smart phone based service, known as Exigency Alert Mobile Cloud (EAMC) provides a quick way of notifying the predicate exigency-handling department, applying the services of Fog and RRP for offloading as well as pre-processing purposes. The service sends the location of incident and contacts to the appropriate exigency-handling department and to family members automatically through already stored contact numbers. RRP aims to discover multiple bidirectional routes between a sensor node and a sink node. RRP achieves load balance by sending data packets via the route with lighter workload. The emergency related information is synchronized automatically from Fog to the Cloud.

Keywords-- Fog computing, Low end-to-end delay, Micro data center (MDC), Mobile cloud computing, Reliable data packet delivery.

I. INTRODUCTION

Exigency refers to an immediate risk posed to life, health, environment, or asset. Exigency has no calendar and one can come across any sort of such situation anywhere, at any time. Whether in the form of an accident, terrorism, robbery, kidnapping, fire breaking out, building collapse, murder. It has become urgent to have a simple and quick way to notifying the concerned department to deal with the disaster. Exigency management depends a lot on how quickly and exactly the situation is informed to the right people. With today‘s age of advancements in smart phone technology, it is more efficient to utilize the technology for exigency management. Mobile cloud computing provides more capabilities to create sophisticated services.

Currently available techniques do not expeditiously handle exigency notification techniques. Most of the processes predominant around the world require the victim or witness to decide the type of exigency first and then find out which departments must be contacted. For example, in case of a fire breaking out, ambulance, fire engine and police have to be called. Manually finding out the contact numbers and departments is not only ineffective, but also, at the time of exigency, it creates panic or terror and affects intellectual thinking process. This could cost life as well. A few seconds could save a lot of lives in the situation like earthquake or tsunami. Depending on application, data packet transmission in a sensor network could be periodic, event-driven or both.

Cloud computing, along with Fog computing, can play a very vital role in not only exigency alert process, but also, in the overall exigency management. Cloud computing platform provides vastly manageable and expandable virtual servers, computing resources storage resources, virtual networks, and network bandwidth, according to the requisite and affordability of customer. It also provides solution to process distributed content. Moreover, data can be accessed far and wide destitue of the trouble of keeping large storage and computing devices. Large amount of content can also be shared and cooperated easily with cloud computing.

Fog computing extends traditional cloud computing paradigm to the edge (Edge Computing). It is a Micro Data Centre (MDC) paradigm, being virtualized, able to provide computation, storage, and networking services between the end nodes and cloud environment. Fog computing is aimed at services with widely distributed deployments. Because of being localized, it provides low latency communication and more context awareness. Fog provides real-time delivery of data, especially for delay sensitive, exigency, and healthcare related services. Fog helps resource-forced nodes offload the rich tasks. It can pre-process the raw data and notify the cloud, before cloud could further adapt that data into enhanced services.

Reliable Routing Protocol (RRP) for wireless sensor networks aimed to maximize routing reliability and minimize routing overhead by discovering multiple routes from each sensor node to a sink node. Routing protocol discovers loop-free routes with each route being verified as a bidirectional communication path between a sensor node and the sink node. The route optimization tries to select disjoint routes as much as possible. Each route is uniquely identified in the network so that the node knows exactly which route to be used for sending or relaying packet. The proposed RRP provides capability to realize load balance and it can be optimized for lightweight process routing.

Although, there has been a lot of work on exigency management, but current solutions do not address exigency notification in an effective and simple way. In this paper, we present a service architecture for exigency alert and management, through Fog, RRP and cloud computing. Our system, Exigency Alert Mobile Cloud (EAMC) tackles different kinds of exigency situations in a very simple and effective way. User only has to press a button, the application itself decides which departments have to be informed, including the location of the event happened. EAMC also informs the family members automatically, by sending messages to already stored contacts numbers.

In rest of the paper, section II is on already done work. Section III is on our proposed system. We evaluate and discuss the results of our system in section IV. Our paper concludes in section V.

II. RELATED WORK

This section discusses the already done works that are related to our area of focus, Twitter proposal by Jie Yin discuss on a system that uses natural language processing and data mining techniques to extract related situation awareness information from Twitter messages generated during various disasters and crises. System architecture is presented for leveraging social media to enhance emergency notifications. High-speed text streams retrieved from Twitter during the incidents are the data sources in this system. Again, it is dependent upon how effectively and efficiently the information is retrieved and made useful. This twitter proposal handles only the exigency related to the vehicles.

Hannes Tschofenig propose IP-based emergency service. Emergency Context Resolution using Internet Technologies (ECRIT) IETF GEOPRIV Working Group related to this sub-domain. GEOPRIV focuses on protocols and techniques required to develop a robust exigency architecture, which would be able to function on all types of IP-based networks. The caller needs to acquire location information for exigency notification, the end systems or proxies have to identify an emergency call and then mark and route it to the proper Public Safety Point (PSP). In this case, either the end host or proxy determines the location of the host. For initial location-based routing, either end host is responsible or the Session Initiation Protocol (SIP) proxy. This all process is vulnerable to location spoofing. Furthermore, a simple and quick mechanism is required for notification, which this mechanism clearly lacks.

The study discussed by Lin Dajian et al. is on formation of resources, which are required for judging exigency rescue process to have a balanced and optimized configuration of the resources. To determine the levels of the emergency response capabilities in industrial accidents, it is essential to have a balanced resource allocation, for effective rescue process. This study 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 magnitude cannot be predicted, Exigency Resources play a vital role in exigency rescue process, because they are directly related to the accident‘s classification disposal of exigency plans. Exigency resources mainly include four types of entities: human, machine, environment, and management. Human, with some exigency training can learn exigency measures and judge potential risks involved in the accidents and the possibility of accident happening correctly and immediately. On the other hand, machine deals with the safety and facilities for handling exigency situations. Exigency channel, quantity, exigency equipment‘s type, performance, storage locations, and standby facilities are all that a machine has to deal with. Management is mainly mirrored in whether the whole exigency tackling process can be performed properly ,efficiently and effectively.

In another twitter proposal by Kathy Pretz discusses utility of Twitter for emergency alert. The author states that a developing situation can be assessed through the data gathered from Tweets. The prototype service in this regard uses data-mining techniques to parse high-volume Twitter streams and identify early indicators of a potential incident. The prototype service is deployed in Australia. The program continuously collects and analyzes tweets from different locations throughout Australia, using data-capture module. The authors claim that Twitter‘s is increasing; hence, it would be easier to report an incident. With this proposal, one issue is that when a disaster strikes, the volume of tweets can be overwhelming to be monitored and extracted. Besides, it totally depends upon those people who use Twitter and are online at that time, tweeting about that happened incident. Even in the developed countries with very high literacy rate, not everyone uses social media. Twitter‘s users would even be lesser then. This mechanism also has to deal with a large amount of tweets and complex algorithms. Instead, emergency management requires a more efficient and easier way, prevalent not only in Australia, but elsewhere as well, specially under-developed countries. Emergency alert process should be simple for an illiterate person as well.

III. EXIGENCY ALERT MOBILE CLOUD (EAMC) WITH FOG AND RRP

In our system, our objective mainly was to overcome the prime issue of complexity and delay in exigency notification.

Data is communicated to the Fog, which sends alert to appropriate emergency tackling departments and family members of the victim through the reliable routing protocol. Later on, data is pre-processed, filtered, and then uploaded to the cloud, which analyses it and further creates extended portfolio of services.

Among the available services, none of them is capable enough through which appropriate exigency 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. Our system not only does that, at the same time, a message is sent to the close family members of the user.

In our case, proposed EAMC maintains a list of those family members. With this, user does not need to find out which department to be communicated and search for contact numbers of family members at the time of exigency. User will only click on the type of event; rest of the things will be done by the application, in coordination with the Fog and RRP. The basic interface currently provides seven different types of emergency notification options. Figure 1 shows the basic interface.

As mentioned earlier, the data may be uploaded in the cloud, which helps related departments for better planning and betterment of the future. All concerned departments will be able to access all type of incidents' information over the cloud and analyze it. For instance, if some area experiences more accidents at nighttime due to bad light or sharp turns, then that issue can be tackled in future.

Hospitals and ambulance service providers can see which locations are more suitable to have their resource point or exigency vehicles are located, 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.

Figure 1.Basic interface of proposed EAMC.

In case of exigency situation, instead of thinking about whom to contact and how to contact and then inform to 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 exigency dealing department by sending a short message, including the place of that event, shown in figure 2.

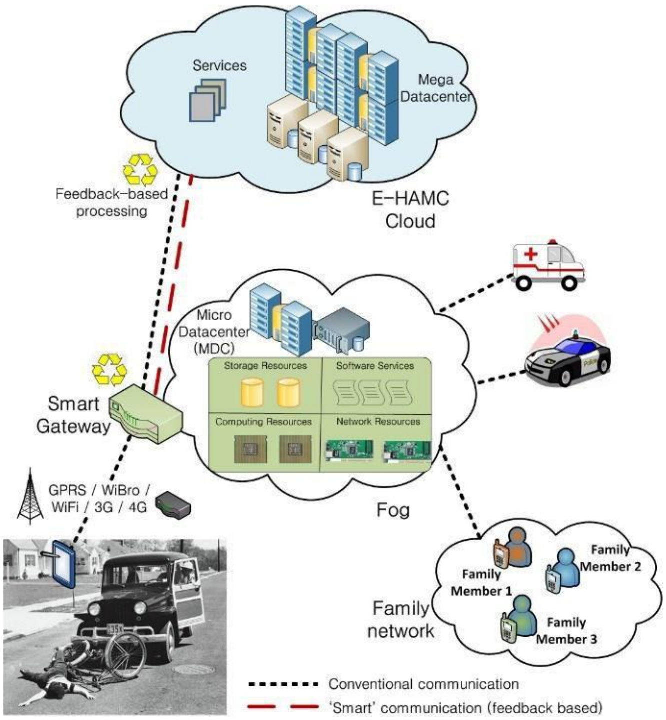

Figure 2. EAMC communication pattern.

Once the alert has been made by the Fog, data is pre-processed for further refinement and then sent to the cloud. Concerned authorities can gather the data from the cloud, when needed, to analyze which kind of exigency 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 life of a people.

A sensor node can receive multiple copies of the packet broadcasted by its neighbors. Based on the received copies of the packet, a sensor node selects two reverse routes to the sink node. The route selection criteria vary according to the different cost functions such as the hop count, the link quality, etc. In this paper, we use hop count as cost function to discover two disjoint routes as much as possible. The disjoint routes fail independently and therefore, the reliability is enhanced.

Operations in sensor networks may require bidirectional routes. In a wireless sensor network, the communication links may exhibit asymmetric properties. For some applications, it is required that the reachability of a node is verified before the routes can be used [6]. Initial route construction process uses a broadcast. The routes discovered are only valid for one direction from the sink node to sensor nodes. Therefore, routes must be verified as valid routes from sensor nodes to the sink node. The route verification also provides the sink node with downward routes to sensor nodes.

The route verification is performed by using the RV packet and the RC packet. To verify a route, a sensor node unicasts a RV packet to the sink node with DT set to 1 via the route specified by NL field in RV packet. Upon receiving a RV packet, the sink node stores route information and unicasts a RC packet back to the sensor node along the reverse route. When the sensor node receives the RC packet, the route has been verified to be a bidirectional route.

Intermediate sensor nodes relay the RV and the RC packets. When a sensor node on the route receives a RV packet and it stores route information and forwards the RV packet to the next hop node. The stored route at intermediate node serves multiple purposes such as relaying the RC packet back to the source node of RV packet, load balance and aggregated route verification.

In aggregated route verification, a shorter route is verified as a portion of a longer route. To increase the probability of the aggregation, longer routes are preferred to be verified earlier. To perform aggregated route verification, a sensor network can estimate packet propagation time based on network diameter and wireless technology used. Before transmitting the RCD packet, the sink node can broadcast a time packet to be used by sensor nodes to estimate when route verification starts,

A Contacts should be updated according to the victim or user location

When a user has changed its location and moved to another city or country, the contacts of emergency dealing departments haveto be updated. In the new location, the application contacts the cloud and synchronizes contacts lists, along with the availability of different types of departments, dealing different sorts of disasters. By this, user never has to manually update. Users are kept always in ready state to use the application.

B. Handling of clowning appraisal in exigency notifications

Handling clowning appraisal completely may not be possible. But at least a notable effort can be made in this respect. In our system, once an exigency situations rises, the victim send picture of the event, which is then sent to the Fog automatically by the application. Since the service is going to be used with smart-phones, therefore, having camera in the equipment is not an issue. In case the victim is not in a situation to do that, any passer-by can take picture and inform the concerned departments with documentary proof. This mechanism will at least help reduce clowning appraisal, if not eliminate it.

IV. PERFORMANCE EVALUATION

The test setup was in such a way that smart phone having EAMC installed was used as end node. Our Real-time Mobile Cloud Research Center (RmCRC) private cloud XenServer was used for Fog communication. Dropbox was used as cloud storage service, where Fog uploads the data in the end using RRP through sensor nodes. Different access networks can be used in this regard. Our evaluation is based on WiFi, WiBro, Broadband, and 4G networks. Final presented results are average of all captured data analyses. The evaluation with respect to the scenarios.

In scenario 1, evaluation is on end-node to Fog communication. In scenario 2, evaluation is on end-node to cloud communication. 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. 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 100 instances of users, who are using EAMC service and notify for different exigency situations to the concerned departments. Results are average of all instances.

A. End-node to Fog

Table 1 shows that 20MB data communicated from end-node to Fog takes an average of 7.84 seconds. This data is then processed by the Fog (through RRP) further and after refinement, uploaded in the cloud.

Table 4.1 UPLOAD DELAY END-NODE TO FOG

DATA SIZE	20MB
UPLOAD DELAY	7.84sec

In the second form of data-set, bulk-data of different sizes was used. The result presented in table 2 shows average of 10MB bulk-data set, which contained images, location coordinates, and text. It takes 4.4 seconds to communicate 10MB bulk-data to the Fog.

Table 4.2 UPLOAD DELAY END-NODE TO FOG

DATA SIZE	10MB
UPLOAD DELAY	4.4sec

B. End-node to Cloud

This part shows that if there is no Fog involved between the end node and the cloud, the overhead is comparatively increased and delay incurred is more than the previous scenario.

Shown in table 3, uploading a 20MB video file to the cloud takes about 69.3 seconds. This is hence the average time to upload the stated size of video or multimedia data on the cloud. This shows that compared to non-Fog scenario, the incurred delay is up to 9 times.

Table 4.3 UPLOAD DELAY END-NODE TO CLOUD

DATA SIZE	20MB
UPLOAD DELAY	69.3sec

When an already uploaded content is to be relocated in the cloud or its attributes are changed, the cloud has to re-configure its URL, since every file has a unique web identity in the cloud. This relocation or change in the attributes requires synchronization. For a service being accessed by more than one node or user, collaborative environment is created, which requires more time to synchronize and update the contents. Average time to synchronize data is shown in table 4.

Table 4.4 SYNCHRONIZATION DELAY CLOUD

DATA SIZE	ALL
SYNCHRONIZATION DELAY	04sec

SYNCHRONIZATION DELAY FOR COLLABORATIVEWORK	09sec

V. CONCLUSION

Notifying incidents in an efficient way is becoming very important. In this work, we focused on the issue of quick and easy way of notifying for different sorts of emergencies or disasters. Our objective was to keep the victim from thinking too much and analyzing at the time of catastrophe. The victim or witness has to just press one button to inform about the type of event. The service automatically decides and contacts relevant departments. Fog computing and reliable routing protocol are incorporated in the model to provide resource hungry task offloading and pre-process the data. Later on, data is communicated to the cloud for more enriched services through RRP. The evaluation of the system endorses the utility of Fog in this particular scenario. Generally, with Fog, the overall delay was around six times less than the otherwise case, when data is to be directly communicated to the cloud by the end node and RRP aimed to maximize routing reliability and minimize routing overhead by discovering multiple routes from each sensor node to a sink node with network-wide broadcast flood. Routing protocol discovers loop-free routes with each route being verified as a bidirectional communication path between a sensor node and the sink node and each route is uniquely identified in the network so that the knows exactly to which route to be used for sending a packet.

REFERENCES

[1] Mohammad Aazam and Eui-Nam Huh, ―E-HAMC: Leveraging Fog Computing for Emergency Alert Service‖ in proceedings of the 5th IEEE International Workshop on Pervasive Networks for Emergency Management,2015.

[2] Jianlin Guo, Philip Orlik, Jinyun Zhang and Koichi Ishibashi, ―Reliable Routing in LargeScale Wireless Sensor Networks‖ Ishibashi.Koichi@ce.MitsubishiElectric.co.jp 2015.

[3] Gautam S. Thakur, Mukul Sharma, Ahmed Helmy , ―SHIELD: Social sensing and Help In Emergency using mobiLe Devices‖, in the proceedings of IEEE Global Telecommunications Conference, Florida, USA, 6-10 December, 2010.

[4] Srikumar Venugopal, Han Li, Pradeep Ray, ―Auto-scaling emergency call center‘s using cloud resources to handle disasters‖, in the proceedings of 19th IEEE Inernational Workshop on Quality of Service, San Jose, California, USA, 6-7 June, 2011.

[5] Go Hasegawa, Satoshi Kamei, and Masayuki Murata, ―Emergency Communication Services Based on Overlay Networking Technologies‖, in the proceedings of IEEE Fourth International Conference on Networking and Services, Gosier, Guadeloupe, 16-21 March, 2008.

[6] C.E Perkins, E.M Royer and S.R Das ―Ad-hoc On-demand Distance Vector (AODV) routing ‖ http://tools.ietf.org/html/rfc3561.

[7] V.D Park and S.M Corson, ―A Highly Adaptive Distributed Routing Protocol(DSR) for MANET‘s for IPv4‖ , http://tools.ietf.org/html/rfc4728.