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An efficient early earthquake alert message delivery algorithm with multi-ISP channels

移轉技術分項計畫子計畫五

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An efficient early earthquake alert message delivery algorithm with multi-ISP channels

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摘要

台灣地震發生的機率非常高，中央氣象局也發展了和其他國家類似的地震預警系統。我們在這篇研究中說明了目前預警系統的現況，並提出改用 SIP 針對各 ISP 使用者發送簡訊取代現有的私有訊息協定．藉由考量傳遞頻寬的議題，我們的演算法有效的降低了訊息傳遞的壅塞，並確保訊息能及時的傳遞．
關鍵詞：地震/短訊/頻寬/緊急訊息。

Abstract

In Taiwan, the earthquake is expected to occur with high probability. The Central Weather Bureau of Taiwan develops the early earthquake warning system as the other nations. We introduce the development status for the system in this paper and propose replace the private commutation protocol with Instant Message(IM) base on Session Initiation Protocol(SIP) for delivering the emergency alert with multi-ISP. By improve the message delivery algorithm with bandwidth information; we can reduce the burst message traffic to network but also send the message on time.
Key Words: earthquake / IM/SIP /bandwidth/ emergency message

1. Introduction

Earthquake is the one of disasters in the world. In 2011 a major earthquake occurred in japan, which the earthquake calculated to be at the Micron Log 9. According to official estimates, 6000 people killed, 10000 missed by the tsunami in the same area. The situation are similar to 1999 Chi-Chi Earthquake in Taiwan、1923 Kanto Earthquake in Japan and 2008 Sichuan Earthquake in China.

However, the early earthquake warning system announces the warning message 10 seconds before the earthquake arrives. The major research for early earthquake warning system focus on three issues – (1) collect the data from the sensor nodes (2) simulate earthquake to get the predictive result (3) deliver the message. By the recent advent of commutation network, real-time earthquake information can be detected and calculate the predictive Micron Log for nation-wide locations. In the paper, we will introduce the related research and purpose the algorithm to deliver the warning message.

Most of the people [1][2] use digital seismometers or customized sensors to collect the data form the sensor nodes. In [3], the author tries to use the three-axis acceleration information in Hard disk or smart phones as a collaborative sensor system. [4][5][6] focus on using wireless mesh network、wireless sensor network 、P2P technology to collect the data rapidly. The information will be the input for calculating the predictive Micron Log in nation-wide locations. Right now, [7][8][9][10] can finish the simulation in seconds.

Several studies about earthquake early warning system are carried out in Japan. In 1992, the japan launches the UrEDAS service (Urgent Earthquake Detection and Alarm System) [11]. In 2007, the Japan Meteorological Agency (JMA) started providing the Earthquake Early Warning by several means such as TV and radio. [12][13][14][15][16][17] try to provide the information to the mobile users、Home automated systems and vehicles.

The most important issue for early earthquake warning system is delivering the emergency message. SMS is the most popular solution for message delivery. However the price and performance issue is the leak. [18][19][20][21] try to use SIP or IMS based message delivery mechanism. In this paper we introduce the early earthquake warning system in the Introduction and analysis the status of current SIP/IMS based message delivery mechanism in Related Work. Then we will purpose our system architecture and message delivery algorithm with bandwidth information to reduce the useless message traffic issue. Finally we will verify our algorithm by simulating with MATLAB and make a conclusion.

2. Related Work

2.1 Short Message Service (SMS)

Even the SMS messaging may be the most popular message delivery mechanism, it works with several disadvantages. Cost is the first disadvantage – if government would like to send the message to large group that it will cost a lot of money. The modern

SMS server only can handle two million messages per hour (around 500 messages per second).The second disadvantage – although SMS message delivery is usually rapid, receipt time and reliability can't be guaranteed. In [22], it shows approximately 5.1 percent of messages were not delivered at all. It is only 1.6 percent to the end to end message loss rate.

2.2 SIP / IMS Messaging

IMS and SIP is the most popular communication protocol today. A lot of studies [23][24][25] try to deliver the emergency message on SIP/IMS platform.

SIP/IMS clients provide much more multimedia capacity [26] compares with SMS. They usually use Session Initiation Protocol for Instant Messaging and Presence Leveraging Extension (SIMPLE) as the message format. The message flow shows in Fig1. There are a number of benefits with SIP platform, such as explicit rendezvous, tighter integration with other media-types, direct client to client operation. To reduce the overhead for message delivery, RFC3428 (page-mode message) is the simplified mechanism for the SIP short message delivery. The message flow shows in Fig2.

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Due to the messages will delivery by unicast when the sender sends the message to the group or updates the presence information. The burst message traffic will influence the low bandwidth network and may be blocked by the IPS gateway.

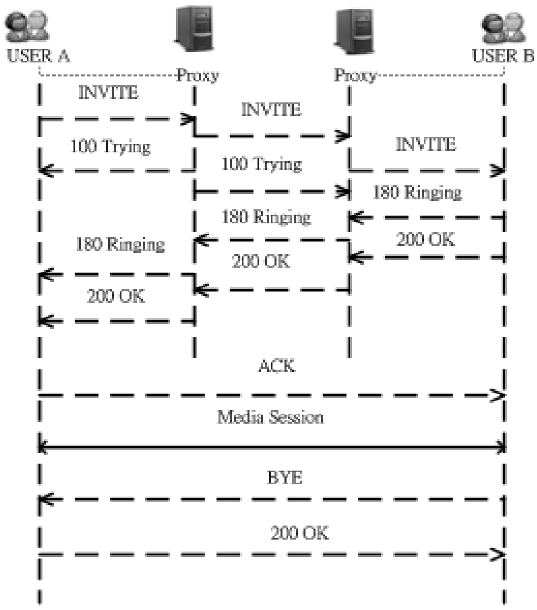

Fig 1 IM Message Flow for RFC3261

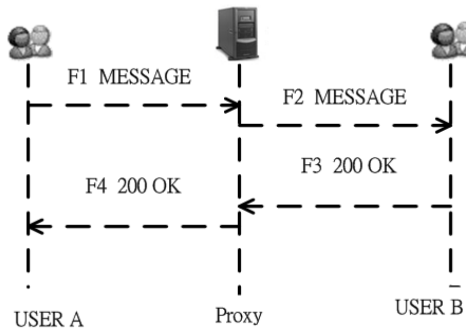

Fig 2 IM Message Flow for RFC3428

2.3 Multimedia Broadcast Multicast Service (MBMS) Messaging

Multimedia Broadcast and Multicast Services (MBMS) [27] is a broadcasting service offered via existing cellular networks. Mobile TV is one of the major applications. MBMS uses multicast distribution in the core network instead of unicast links for each end device. The broadcast capability enables to reach unlimited number of users with constant network load. Japan's early warning system use MBMS function to deliver the emergency alerts. However, the multicast network only work in the particular network.

2.4 Taiwan's early earthquake warning system

CWB can receive the sensor data form the sensors and get the predictive Micron Log for nation-wide locations in 10sec. In Taiwan, the earthquake will take 30sec from Taichung to Taipei. Currently they use Client-Server TCP software to deliver the alerts.

Fig 3 Early earthquake warning system in Taiwan

In whole system architecture shows in Fig3, the CWB tests multi-solutions for a reliable and efficient way to deliver the emergency message. By the Table I, we can understand SIP will be the most appropriate solution for NGN(All IP) alert message delivery system. However most the network doesn't work with the multicast capacity. How to deliver the unicast SIP message efficiency is the most important issue.

3. Efficient Emergency Alert Message Delivery System

We purpose using the SIP page-mode as the next generation earthquake alert system protocol. But it still needs to send message to the users individually because most of the network cannot work with multicast function. When the users register with the service, our system will hold the following information as fig4: (1) network subnet prefix (with C class) (2). Geography location address (3) belongs to which ISP.

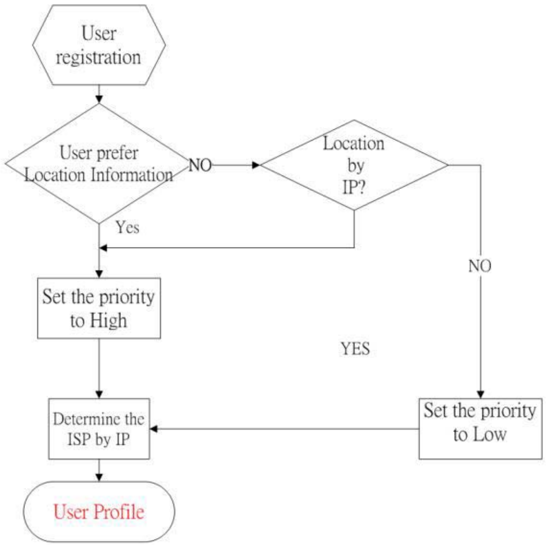

Fig 4 User registration flow

We set the time for earthquake simulation as tcal, CWB has α message servers and each server can handle β messages per second. There are N cities in the system and the earthquake will arrive on t1…..tN. The number of the ISPs in each city is ISPi. The number of users from different ISPs in each city is USERi. Each ISP connects with our service server with limited bandwidth. ISPbandwidth is the bandwidth limitation for each ISP transmits message capacity. If the message in the queue can't be sent on time, it should be dropped from the delivery queue. By this way, we can transmit as many useful messages as possible.

When the USER1 (Management) transmit the alert message to users, the message proxy will resend the message to other users as Fig5. As the pseudo code in Fig.7, we use the greedy algorithm try to process the most urgent event. But we apply the in time limitation for the algorithm. If the message can't be sent in time, it will be skipped. In the normal distribution, the number of message be sent to each ISP is related with the number of users to each ISP. When the required message delivery rate is over the bandwidth limitation, the server will transmit the message to other ISP users with remaining capacity. The detail decision flow shows in fig6.

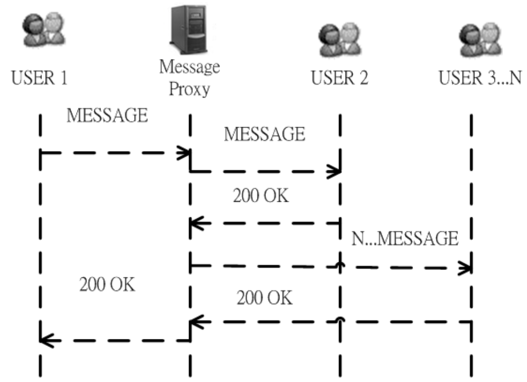

Fig 5 Message delivery flow

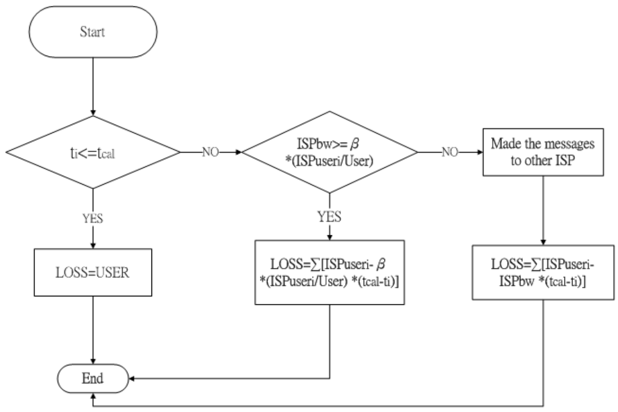

Fig 6 message delivery decision flow

For(i=1;i<=n;i++)
{
  if(t_i<=t_{cal})
  {
    //before the simulation finish
    $LOSS_i = USER_i$;
  }
  else
  {
    //after the simulation finish
    /*if the number of average allocation messages is not larger than bandwidth , then we will not use the algorithm*/
    If($ISPbw >= \beta*(ISPuser_i / User)$)
    $LOSS_i = \sum_{1}^{i} [ISPuser_i - \beta*(\frac{ISPuser_i}{User})*(t_{cal}-t_i)]$;
    else
    {
      /*if the number of average allocation messages is larger than bandwidth , that we made the messages to not larger than bandwith*/
      $\beta*(ISPuser_i / User) = ISPbw_i$;
      /*and then the messages allocated to other ISP*/
      The Messages to other ISP;
      $LOSS_i = \sum_{1}^{i} [ISPuseri - ISPbw*(t_{cal}-t_i)]$;
    }
  }
}

Fig 7 Pseudo code for message delivery

We develop the protype to demo our idea . Fig 8 show the main userinterface for our appliaction. User can use the sip account to lgin the system and set the perfer location. Fig9 show the alert according to recived warning message.

Fig 8 Pseudo code for message delivery

Fig 9 Alert message

4. Simulation

We use the data comes from 1999 Chi-Chi Earthquake in Taiwan, Table1 show there are 23 major sensor stations in Taiwan(N=23). We assume there are three ISPs in Taiwan (ISPi=3).The amount of users to each city is 10000 (ISPUSER1 +ISPUSER2 +ISPUSER3 =10000).More detail information can be seen in Table2. The system will take 10 sec to finish the simulation (Tcal=10). CWB have one message server that can handle 5000 message/sec (α=1, β=5000). ISPbandwidth is 2000 messages/sec

Table1. History data for 1999 Chi-Chi Earthquake

Station ID	Distance/ time	Station ID	Distance/ time
City01	5.53KM/1.38s	City13	109.6KM/27.4s
City02	21.42KM/5.35s	City14	109.9KM/27.4s
City03	26.13KM/6.53s	City15	123.7KM/30.9s
City04	38.32KM/9.58s	City16	129.1KM/32.2s
City05	41.61KM/10.4s	City17	132.3KM/33.1s
City06	55.97KM/13.9s	City18	137.3KM/34.3s
City07	62.64KM/15.6s	City19	142.5KM/35.6s
City08	64.52KM/16.1s	City20	154.6KM/38.6s
City09	66.02KM/16.5s	City21	156.7KM/39.1s
City10	78.89KM/19.7s	City22	171.2KM/42.8s
City11	99.10KM/24.7s	City23	214.5KM/53.6s
City12	103.8KM/25.9s		

Table2. The number of ISP users to each city

Station ID	ISPUSER1	ISPUSER2	ISPUSER3
City01	4000	3000	3000
City02	5000	3000	2000
City03	7000	1000	2000
City04	6000	3000	1000
City05	4000	3000	3000
City06	8000	1000	1000
City07	3000	4000	3000
City08	2000	5000	3000
City09	1000	2000	7000
City10	500	8000	1500
City11	2000	3000	5000
City12	1000	2000	7000
City13	3000	4000	3000
City14	7000	1000	2000
City15	5000	4000	1000
City16	4000	3000	3000
City17	1000	5000	4000
City18	5000	4000	1000
City19	4000	1000	5000
City20	1000	6000	3000
City21	5000	1000	4000
City22	2000	2000	6000
City23	6000	1000	3000

From the result in Fig10, it shows the messages that should be sent before tcal is identified as useless message. In the test, we deliver the messages without considering bandwidth limitation. In Fig 11 shows the message delivery with considering bandwidth limitation. We can see less number of delivery dropped messages. In Fig 12 shows the total number of message delivery difference. Finally, there are XXXXX messages are dropped without considering bandwidth limitation and XXXXX messages are dropped with considering bandwidth limitation.

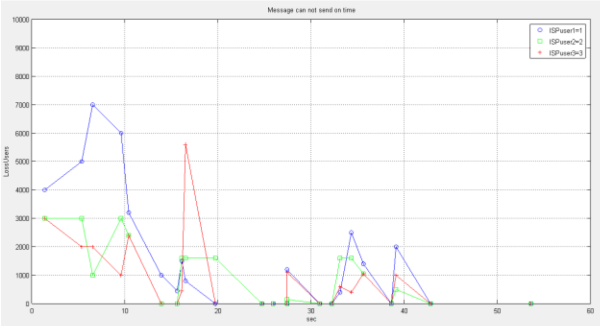

Fig10 alert delivery without considering bandwidth

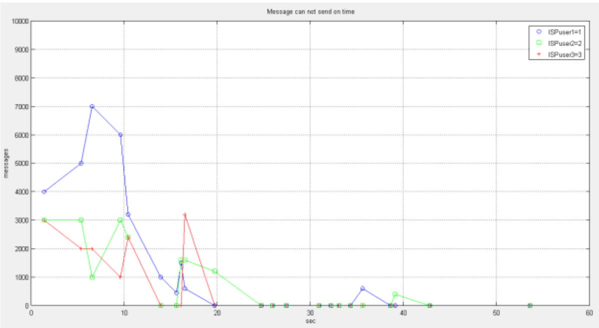

Fig 11 alert delivery with considering bandwidth

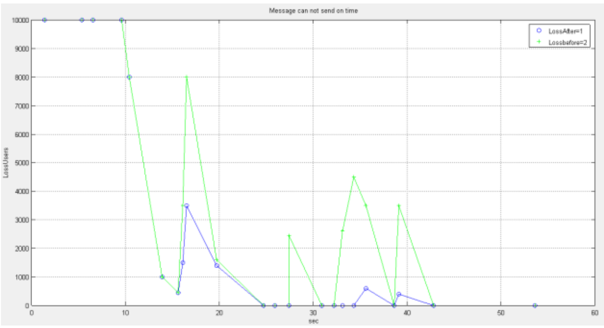

Fig 12 number of dropped messages

5. Conclusion

We propose replace the private commutation protocol with Instant Message(IM) base on Session Initiation Protocol(SIP) for delivering the alert message .By scheduling the message delivery with location information and bandwidth limitation, we can reduce the burst message traffic for network but also deliver the message on time with fewer servers.

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