

# Emergency Broadcast System Based On GIS

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**Abstract.** Nowadays, disaster occurs more and more frequently, which brings huge losses to the society. Presented a GIS based emergency broadcast system (GIS-EBS), to provide rapid, accurate information to the public, can reduce the people's losses maximum. Different from the traditional radio data system (RDS), by adding broadcasting terminal control instruction on the FM signal, GIS-EBS extended the RDS protocol, which can control each radio terminal's state. And through the extended RDS protocol, GIS-EBS can broadcast and release the emergency information to the right place and the people most in need in the shortest time.

## 1. Introduction

More and more extreme natural disasters continue to emerge, which put forward a higher request that the emergency management needs to be strengthened and be improved. In the process of occurring M9.0 earthquake in Japan[1], many people successfully managed to escape the danger in a short time because they heard the alarm broadcast before the earthquake. Similarly, broadcast played a significant role in Wenchuan the M8.0 earthquake as well[2]. It had proved that the broadcast is the quickest and most effective approach of signal transmission in the critical situation.

Wang[3] proposed to build the national emergency broadcast architecture, which focusing on clarify the

level of emergency, and combining emergency response and prevention. Through researching the Japanese natural disaster emergency broadcasting system, Guo[4] analyzed the problems and deficiencies of Chinese disaster broadcasting system. Jiang[5] developed a township's emergency broadcast system based on Radio Digital System(RDS) technology. Wen[6] designed a shortwave remote terminal waken method, that used in the development and application of country's emergency broadcast system.

Adding digital signal to the FM has become the trend of the construction of the emergency broadcasting system. By extending the RDS protocol, proposed a GIS-based emergency broadcast system (GIS-EBS), GIS-EBS's main characteristics including: Addressable FM radio data system, GIS-EBS operates a set of extended FM-RDS instructions on both PC and encoder, which can combine users' inputting text and voice and the radio terminal control command to FM signal; Radio terminal breakdown

monitor method, in order to manage a large number of distributed radio terminals, developed an active access method by using embed GPRS module, so GIS-EBS can query the terminals' real-time state automatically. Weak signal processing based on spatial analysis, by combining with GIS spatial analysis method[7], GIS-EBS can calculate the most reasonable location to place the radio terminal, which can receive the optimal broadcast signal.

## 2. GIS-EBS 's key technology



As showed in Figure 1, when the unexpected events occurred, GIS-EBS could automatically determine the scope of broadcasting, and convert the emergency signal to radio signal at the first time, according to the type of emergency signal's type and location. The process of emergency signal network transmission was as follows: firstly, emergency signal needs to convert into IP data flow, then it would be sent into the Internet or intranet network by IP Protocol Transmit Device, secondly, RDS Protocol Encoder would receive the IP data flow, and convert it to the RDS data, finally, RDS Protocol modulator would modulate RDS data into FM signal, sent to the broadcasting terminal on CATV network or unwire FM signal.

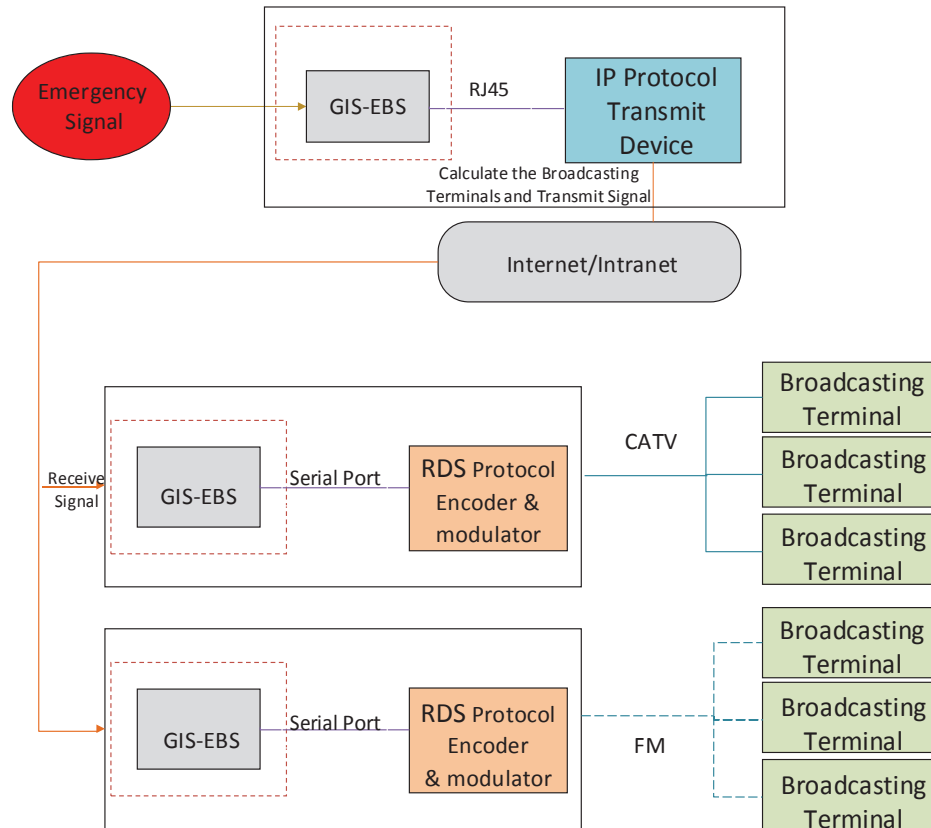


Fig.1 GIS-EBS Topo Framework

## 2.1 Extended RDS Protocol

According to the characteristics of the emergency broadcast, GIS-EBS designs three kinds of communication protocol type: extended RDS protocol, IP protocol, and GPRS protocol. And the extended RDS protocol was the core of GIS-EBS, and it was the key to broadcasting radio accurately. GIS-EBS's Extended RDS protocol was showed in table 1.

Tab.1 GIS-EBS Extended RDS Protocol

	Head	Command type	protocol type	Frame Length	Data	CRC check	End
Length (byte)	1	1	1	2	n	2	1
Default Value	0x24	CMD					0x0A

Taking data "04 01 01 11 10 10 10 10 11 02 02 01 01 0A 00 01 01 92 BC" as an example:

04 (representative data level): county level, 0x01 - Central ,0x02 - province, 03 -city, 04 -county, 05 -country, 06- village.

01(representative data type): Emergency.

01(represents a group of broadcasting terminal): 0x01 - one group, maximum group number - 0x16.

11 10 10 10 10 11: (broadcasting terminal address): length - 6 bytes, on behalf of the province, city, county, country, village, terminal address. Each level's length is a byte.  
02(represents a type directive): 0x01---start, 0x02---stop.  
02 (on behalf of event level): 0x01--- particularly serious, 0x04---normal serious.  
01 01 0A 00 01 (represents the emergency type): 0x01- flood,0x02-debrisflow, 0x03-Blizzard, 0x04-Typhoon.

GIS-EBS's extended RDS signal could add digital information on the FM signal, such as warning area (national\provincial\city (county, district)\township); warning type (earthquake\ tsunami\air strikes\Typhoon\debris flow\flood and other emergency situation), and etc. When the Broadcasting Terminal received the FM signal, it would judge whether or not to response according to the added digital information.

## 2.2 Broadcasting Terminal Failure Detection method based on GPRS

Broadcasting Terminal is usually sprawled across in various areas. The traditional way to checking the Broadcasting Terminal's state was by manual inspection, which was really time-consuming[8]. GIS-EBS implemented an automatic monitor service based on GPRS. The real-time data of Broadcasting Terminal would send its' heartbeat data to the internet network on GPRS protocol, and GIS-EBS's GPRS monitor service can automatically detect the broadcast terminal's heartbeat data, the Broadcasting Terminal's statues would show in the Map Viewer intuitively. If Broadcasting Terminal communication failure, GIS-EBS would alarm the user in real time, so it can make the Broadcasting Terminal's maintenance easier.

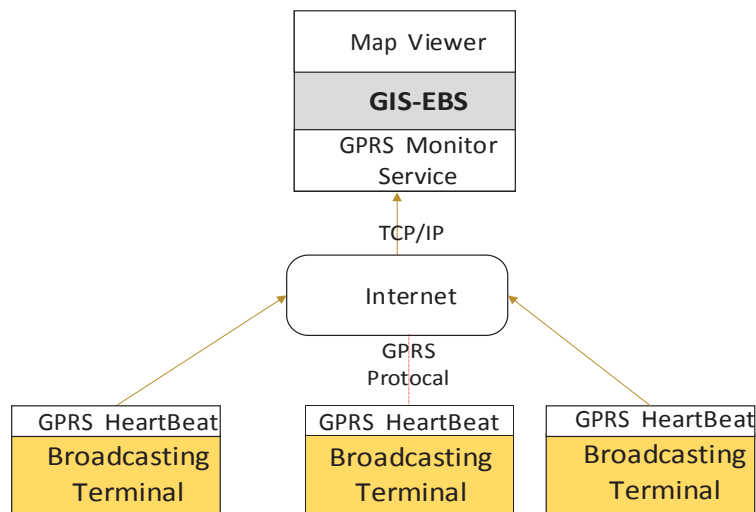


Fig 2 Broadcasting Terminal Failure Detection

## 2.3 Broadcasting Terminal's Location choice based on GIS

Broadcasting Terminal could be received radio signal through CATV network or wireless FM signal, in the complex mountain village area, Broadcast Terminal was usually using FM wireless way to set up. But FM signal suffered some signal attenuation during the long distance transmission; the quality of the FM signal will depend on the receiving environment, frequency shift, time delay, modulation type and other factors [9].

In the complex mountain village area, for the special path, using the following formula (1) [10] to estimate the standard variance of location variability  $\sigma_L$ .

$$\begin{aligned} \Delta h/\lambda < 3000 \quad \sigma_L &= 6 + 0.69 \left[ \left( \frac{\Delta h}{\lambda} \right)^{1/2} - 0.0063 \left( \frac{\Delta h}{\lambda} \right) \right] \quad \text{dB} \\ \Delta h/\lambda > 3000 \quad \sigma_L &= 25 \end{aligned} \quad (1)$$

The parameters in the formula:

$\Delta h$ : Decile height (meters)

$\lambda$ : wavelength (meters)

$\lambda = 300/f$

$f$ : frequency (MHz)

Generally, the standard deviation would decrease with the increase of the distance between the transmitters, and the main factors that affected the  $\sigma_L$  included elevation, vegetation, buildings and so on. Not considering ocean and other special terrain, the received signal strength would increase with the height of the antenna. The experience height of the antenna ( $h_{eff}$ ) was between 3 and 15 km. According to the path length, the optimum height of the transmitting station antenna ( $h_1$ ) could be calculated according to the follow formula.

$$h_1 = h_a \quad \text{for} \quad d \leq 3 \text{ km} \quad (2)$$

$$h_1 = h_a + (h_{eff} - h_a) (d - 3) / 12 \quad \text{for} \quad 3 \text{ km} < d < 15 \text{ km} \quad (3)$$

$h_a$  referred to the antenna height above the earth.

According to the FM signal attenuation equation, by using remote sensing image and DEM data[11], GIS-EBS can analyze the location and get the best height of the antenna in the area, and achieve the reasonable location of Broadcasting Terminals, so that can get the balance between the broadcast signal and construction resources.

### 3. Design and Implementation of GIS-EBS

GIS-EBS's system architecture is showed in figure 1, divided into the hardware layer, protocol layer, business logic layer and user presentation layer.

The hardware layer included IP Protocol Transmit Device, RDS Protocol Encoder, modulator and Broadcasting Terminal. IP Protocol Transmit Device was responsible for converting received emergency signals to IP data, and sending the IP data to Internet or Intranet network; RDS Protocol Encoder and modulator were responsible for convert RDS data to FM signal; Broadcasting Terminal would convert it to RDS signal when receiving the FM signal, and based on the address information in FM signal to determine whether or not execute the command. Besides, broadcasting Terminal would encode its' state to IP data, then send to the wireless network through GPRS module, GIS-EBS would judge broadcasting Terminal whether or not online through decoding the received IP data.

Protocol Layer has three protocols, including RDS Protocol, IP Protocol, GPRS Protocol.

Business Layer has divided into Addressing module and Broadcasting module. Broadcasting module included Emergency Voice Broadcasting, Emergency Text Broadcasting, Daily Voice and Text Broadcasting and Plan Broadcasting. Broadcasting module is enabled to the real-time broadcast of emergency voice signal and text signal. Addressing modules included IP Address Module and GPRS Address Module. IP Address Module was responsible for sending an emergency signal to the specified IP Protocol Receive Device; GPRS Address Module was responsible for sending the terminal state to GIS-EBS.

Presentation Layer included the function of Map Viewer, Boarding and Terminal Fault Detection.

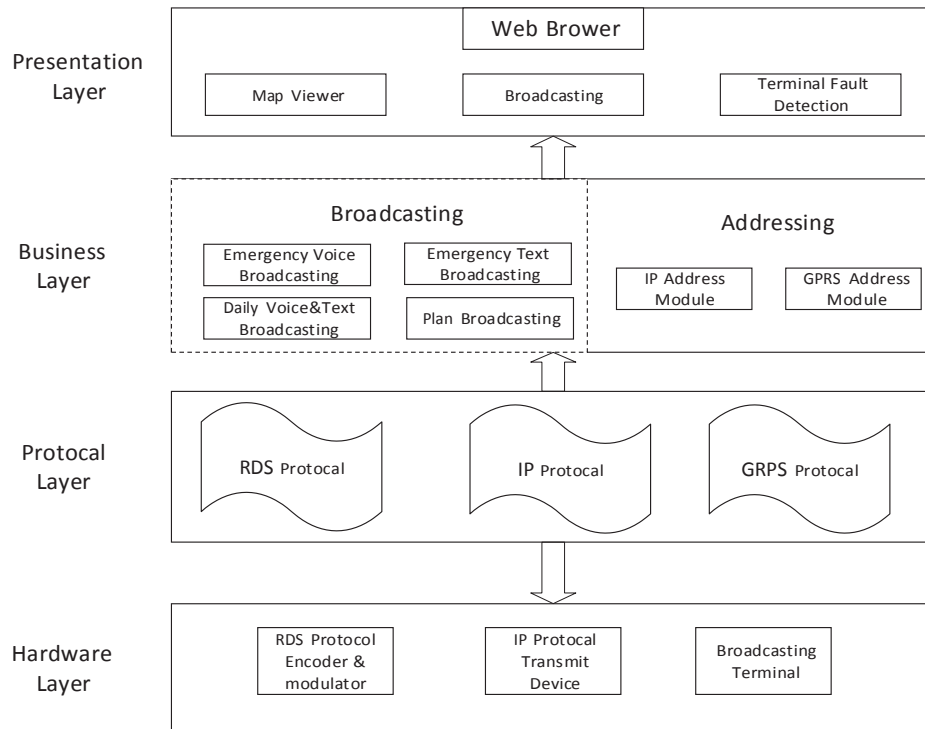


Fig3 GIS-EBS System Architecture

The interface of GIS-EBS was showed in Figure 4. The main function included daily broadcast, text broadcast, emergency broadcast, timing broadcast and fault detection. According to the broadcast plan, GIS-EBS would broadcast on the schedule automatically.



Fig 4 GIS-EBS's running interface

If emergency occurred, GIS-EBS would suspend the current program, and gave the priority to the emergency broadcast information, in addition, the system supports broadcast the text and voice information. When the Broadcasting Terminal was failure, GIS-EBS could display the fault equipment in the map viewer, which provided convenience to quick retrieval and maintenance.

#### 4. Summarize and Future work

The frequent occurrence of natural disasters in recent years makes people aware of the value of

emergency broadcasting, GIS-EBS not only could provide real time and accurate emergency radio broadcasting, but also provide a convenient method to maintenance broadcasting terminal.

In the future, we will combine with the Internet of things (IOT) into GIS-EBS, to provide real-time warning broadcast signal, such as automatic monitoring and information of landslides, earthquakes, and floods, to provide the greater value to the disaster prevention and mitigation.

## 5. Acknowledgments

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