A GPRS-Based Data Collection and Transmission for Flood Warning System: The Case of the Lower Mekong River Basin

Saysoth Keoduangsine and Robert Goodwin

***Abstract*—In order to make an effective flood forecasting and flood warning system, real-time hydro-meteorological data must be collected and transmitted to a control centre for analysis and processing. There are many ways to get this data from remote hydrological monitoring stations such as via a satellite link, sensor networks, telephone, fax, radio or via mobile phone networks[2][10]. This paper describes how to collect and transmit timely hydrological data using GPRS (General Pocket Radio Service) via a mobile phone network from remote hydrological stations to the data centre in the case of the Lower Mekong River Basin (LMRB).**

***Index Terms*—Data collection, GPRS, (The Lower Mekong River Basin) LMRB.**

I. Introduction

An efficient flood warning system requires the use of an automated system for data acquisition, the analysis of the key parameter data (water level, water flows, precipitation and temperature) and the issuing of real-time warnings in the case of the prediction of a flood occurrence. In the last few years, different methods of data collection have been applied by many governments and organisations, these methods include data collection based on sensor networks, GIS (geography information systems), satellites, mobile phones and SMS text messages. The data collection method used is subject to technology availability such as the type of communication networks. For example, in the LMRB countries (Cambodia, Laos, Thailand and Vietnam) sending an SMS text message or making a phone call from the remote hydrological monitoring stations to transmit hydrological data to the data centre is commonly used because mobile phone networks have been widely developed [2], while hydrological data collection in the USA for one system is via Satellite [10].

This paper describes a process of collection and transmission of data which includes water level, water flows, precipitation and temperature from remote hydrological station locations to the data centre via a mobile phone network using GPRS technology. The paper then discusses flood forecasting and warning in the case of the LMRB.

II. Related Work

Using a wireless sensor network for weather and disaster warning is described by Yawut, C. et al [13]. The system uses a wireless sensor network based on the Zigbee/IEEE802.15.4 standard which sends weather information such as temperature, humidity and pressure to a remote server by an XBee module.

Morais, R. et al. implemented a wireless data acquisition network to collect climate data and soil moisture for a smart irrigation system in Portugal in order to improve irrigation efficiency [7]. Several SPWAS (Solar Powered Wireless data-Acquisition Stations) have been deployed for the measurement of soil moisture data and to send it to a control centre.

Banks, et al. have described a wireless network system called SmarkBrick which generates road safety alerts, especially bridge conditions for drivers [1]. The system uses a wireless sensor network to collect data about the bridges including tilt, vibration, temperature and water level. The SmarkBrick serves as the base station and is responsible for data processing and reporting of the collected data. Drivers will be alerted by email and SMS. However, this proposed road safety alert system was an early stage prototype.

A flood early warning system, based on SMS and web, was proposed by Windarto [12]. To record rainfall and water level data, an automatic rainfall recorder was placed in an upstream location on the river, while a water level recorder was placed in a downstream location. A receiving server was located in the government office to receive rainfall and water level data and hence to predict a flood. The system then sends flood status information to attendants and stakeholders via SMS. The website can be accessed anywhere as long as the communication network is available.

The traditional approach for data collection used by the Lower Mekong River Basin (LMRB) countries has been by phone call, SMS text, Fax or emails. The staff at remote hydrological stations routinely take readings of water level, precipitation and temperatures then make a phone call or send SMS texts to the data centre via a mobile phone. If the stations are near a city the data can be recorded in a log book and sent via FAX or emails [2].

III. Case Study

The case study presented in this paper is a discussion of data collection for the LMRB countries (Cambodia, Laos, Thailand and Vietnam) as in Figure 1. The LMRB has its own hydrological system managed by the Mekong River Commission Secretariat, MRCS [3].The system is currently composed of the 32 hydrological stations along the Mekong River and its main tributaries, in locations where the mobile phone network is available. It is designed to monitor key parameter data (water level, precipitation and temperature) to support flood forecasting and analysis of environment impacts and climate change for sustainable development in

Manuscript received March 5, 2012; revised April 22, 2012.
Authors are with the Flinders University of South Australia (e-mail: keod0001@flinders.edu.au; robert.goodwin@flinders.edu.au).

this region.

For flood forecasting and generating flood warnings, the parameter data is collected in real time from the hydrological stations through the mobile phone network. The data is then analysed and used to make flood predictions and issue daily flood forecasting bulletins.

Fig. 1. The lower Mekong river basin [8].

The national television networks, radio stations and newspapers are used to deliver flood information and weather messages to the public, while the telephone system, facsimile, e-mail and the website are used by management, authorities and stakeholders [2]. Additionally, the MRCS has developed an internet-based system for real-time monitoring and visualisation of water levels and rainfall at the main stations for online access. However, residents without internet access cannot view the real–time monitoring graphs which are needed in the case of floods.

IV. The LMRB Flood Warning System Architecture

The high level overview of the flood warning system architecture of the Lower Mekong River Basin is shown in Figure 2. The system is comprised of five major layers. The first layer (data collection) includes monitoring sensors for measuring water level, precipitation and temperature.

The second layer is data transmission, including a data logger and a GPRS modem which reside at the remote hydrological stations. The third layer is data receiving located at the data centre which uses the FTP (File Transfer Protocol) for data transfer. The fourth layer is data processing for producing bulletins and real time water and precipitation graphs. The fifth layer is information dissemination, includes real time graphs and a web server located at the data centre, it makes available real time water level and precipitation information.

V. Data Collection

The data to be collected and sent to the data centre includes the water level, the precipitation and the temperature.

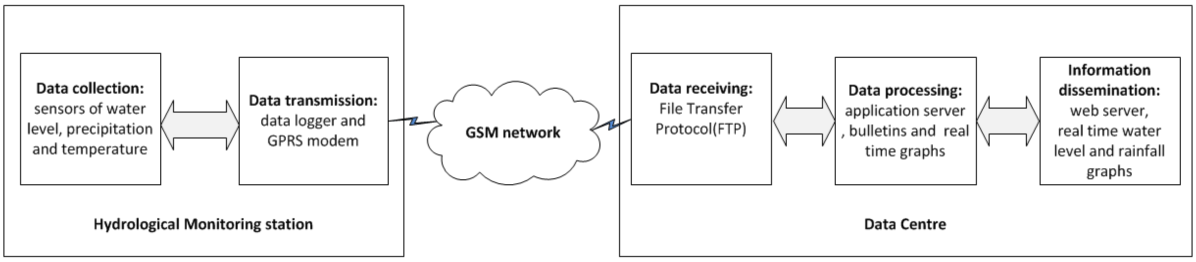

Fig. 2. The high level system architecture.

The voltage of the backup battery is also sent so that staff knows if the battery has malfunctioned. Figure 3 shows the wiring diagram of each remote monitoring station at a remote location.

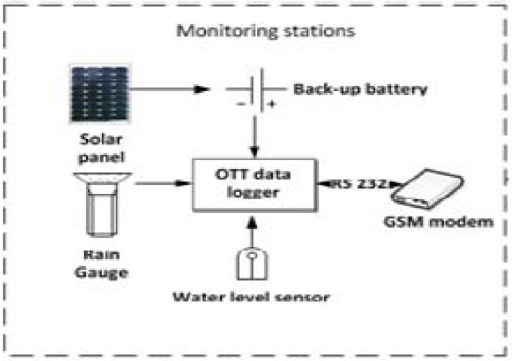

Fig. 3. A wire diagram of monitoring station.

A. Data Logger

The data logger, an OTT DueSens with 4 Mb memory and manufactured by OTT Germany [9], is used to collect, record and transmit the parameter data and can be set up with up to 30 internal channels for recording data.

B. GPRS Modem

The GPRS modem, manufactured by Wavecom Instrument Australia [11], is connected to the data logger and an antenna, and sends the parameter data to the data centre every 15 minutes (depending on the setting).

C. Water Level Sensor

The water level sensor is an OTT compact bubble sensor (OTT CBS), bubble pot and bubble tube, manufactured by OTT Germany [9]. A bubble tube connects the bubble pot, which is deployed under water, to the nearby station. A pressure measuring cell in the OTT CBS measures the air pressure and the prevailing measuring tube pressure successively. By taking the difference between both signals the exact water level can be calculated.

D. Precipitation Sensor

The TB3 precipitation sensor, manufactured by Hydrological Service Pty Ltd Australia, is for recording rainfall [6]. It consists of a bucket rain gauge and tipping system. The sensor uses a reed switch as the main component. The precipitation sensor is connected to a digital input terminal of the data logger. The data logger detects the on/off switching of the sensor reed switch to count the number of times the tipping bucket empties and hence to calculate the precipitation.

E. Power Supply

The monitoring stations are placed in remote areas so the monitoring stations use power from solar power supplies, which consists of a solar panel, a control switch and a rechargeable battery directly connected to the data logger. The battery supports the power supply to all equipment allowing it to run twenty four hours a day.

VI. Data Transmission and Data Receiving

The main data transmission components consist of a data logger, a GPRS modem and a receiving server. The parameter data is sent from the monitoring stations by GPRS modem and the GSM network to an FTP server in the data centre.

The monitoring stations need to be configured before transmission can occur. This configuration includes a station code, mobile phone numbers for the GPRS modem, frequency of sending, and name of destination server with its correct access code. This setting can be configured manually via an RS 232 cable or via an infrared interface at each remote station or online from the data centre.

The parameter data is transferred to the FTP server at 15-minute intervals via the mobile phone network immediately after recording by the sensors and the data logger. If data cannot be sent due to traffic on the network or a low mobile signal level, it is stored in the data logger memory and sent later.

In the data centre, the FTP server receives the parameter data and saves it in the specific folders of each station code.

VII. Data Processing

The data is immediately sent from the FTP server to the application servers for processing to predict flooding and for real-time monitoring. For flood forecasting, the parameter data is processed by flood forecasting model software to make daily bulletins. Figure 4 shows 7-days actual and forecast water levels at the Vientiane station.

For real-time monitoring, real-time graphs of water levels and precipitation are created by a software application and then are sent to a web server to publish online.

Fig. 4. The observed and forecast water level of the LMRB, adopted from [4].

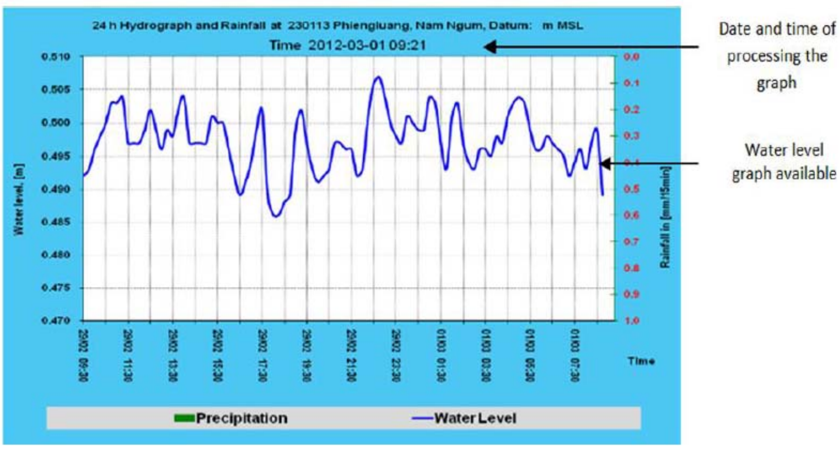

Fig. 5. The Mekong river real time water level monitoring graph [5].

VIII. Flood Warning

Flood information is disseminated in two categories information, flood forecasting and real time monitoring. The flood forecasting information is broadcast in the national news bulletins [2]. The bulletins are sent to the national media such as radio, television stations and newspaper agencies to deliver the flood forecasting and weather messages to the public. The real time monitoring graphs are accessible by users who have online access through a laptop or a personal computer as can be seen in figure 5.

IX. Issues

Some of the issues with the system are:

1) Residents in a risk area might not get a near real time flood alert in case of a flash flood.

2) The real time flood monitoring graphs are not accessible by residents who have no internet access.

3) The mobile phone signal at some stations might be weak, and this could result in delayed transmission.

4) According to the real time monitoring graph (Fig.5), the water level graph available was delayed about one hour compared to the time of the graph creating. This delay might result from the data processing or the data transmission.

X. Conclusion and Future Work

The main objective of this paper was to discuss the flood forecasting system, particularly the process of data collection of the Mekong River Commission for the LMRB countries. The system employs GPRS technology for real-time data collection and transmission of water information from remote hydrological stations to the data centre. The system is composed of five major components, data collection, data transmission, data receiving, data processing and information distribution. The system is implemented at the 32 remote hydrological stations along the Mekong River and its main tributaries; it uses an FTP server as the receiving server in the data centre and distributes flood information to people via the national radio stations, television stations, newspapers and website.

Future work aims to research how to ensure reliable data transmission using GPRS and the mobile phone networks, what are factors might cause a transmitting delays, and to develop a real time flood warning system using SMS to provide people in a risk area with timely warning of a flood.

Acknowledgements

This research is supported by an Australia Leadership Awards scholarship. We are very grateful for this scholarship. The authors also thank the Mekong River Commission Secretariat for providing information for this paper.

References

[1] B. Banks, et al, "A low cost wireless system for autonomous generation of road safety alert," view online Google scholar on 5th Nov 2011. Available: http://transportation.mst.edu/documents/Sedigh_2009_SPIE_7.pdf

[2] "Flood Risk Management and Mitigation in Mekong River Basin," *8th Annual Mekong Flood Forum 2010*, viewed on 1st Nov 2011. Available: http://www.mrcmekong.org/assets/Publications/basin-reports/Annual-Flood-Report-2010-2.pdf

[3] Mekong River Commission Secretariat, viewed on 2 Feb 2012. Available: http://www.mrcmekong.org

[4] Mekong River Commission, "River Monitoring", viewed on 3 Jan 2012. Available: http://ffw.mrcmekong.org/stations/vie.htm

[5] Mekong River Real time water level monitoring, viewed on 1st Mar 2012, Available: http://monitoring.mrcmekong.org/

[6] Meteorological equipment, viewed on 2 Jan 2012. Available: http://www.hydroserv.com.au/index.htm

[7] R. Morais, et al.," A wireless sensor network for smart irrigation and environmental monitoring", *EFTA/WCCA Joint Congress on IT in Agriculture*, Patugal, 2005, pp.845-850, viewed on 2nd December 2011

[8] MRC Annual Mekong Flood Report 2010, viewed on 11th Nov 2011. Available: http://www.mrcmekong.org/about-the-mrc/programmes/flood-management-and-mitigation-programme/

[9] OTT hydromet. Available: http://www.ott.com/web/ott_uk.nsf/id/pa_home_e.html

[10] Real-Time Water Data via Satellite Telemetry in Florida, viewed on 2 Feb 2012. Available: http://soundwaves.usgs.gov/2007/06/

[11] WaveCom instruments, viewed on 3 Dec 2011. Available: http://www.wavecom.com.au/

[12] J. Windarto, "Flood Early Warning System Develop at Garang River Semarang using information Technology base on SMS and Web," *The International Journal of Geomatics and Geosciences*, vol.1, no.1.2010. Available: http://www.ipublishing.co.in/jggsvol1no12010/EIJGGS1002.pdf

[13] C. Yawut, et al," A wireless sensor network for weather and disaster alarm systems", *Int. Conf. on Information and Electronics Engineering*, vol.6(2011),Singapore, viewed on 10th Dec 2011. Available: http://www.ipcsit.com/vol6/31-E078.pdf