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Multi Router Traffic Grapher Monitor Implementation

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Abstract:

Wireless sensors are capable of collecting real-time data not only from the environment, but also from the signals that the human body can generate. These small and smart tags may act as another layer of infrastructure between the internet and the physical world. However, a complete system of software tools, gateway devices and reliable communication channels are needed to achieve this bridging. In our test bed we tested the limits of implementing motes based system using commodity based hardware. In this paper, wediscuss a portable and remote health monitoring system using wireless sensors, based on a persistent monitoring of bio-signals from an unwell or elderly person, using the concept of Body Area Network. The entire signals not only from the body but also from the environment, will be stored in a web server and displayed graphically using an existing tool for monitoring network traffic, namely Multi Router Traffic Grapher. The aim is to allow secure remote access to certain health parameters in order to alert carers to abnormal body signs, and provide a complete data collection at doctor's disposal. Consequently multi router traffic grapher can facilitate the determination of how changes in the environment affect vital signs. The researchers demonstrate that wireless sensors have a very high level of integration with existing tools related to network monitoring. This will enable a new and powerful method for joining physical and networks layers.

Key-Words: wireless sensor network, body area networks, health

1.Introduction

Doctors could detect some anomaly if they had a real time access to patients' vital signs. In this way, not only cost but also time would be saved in healthcare. Preventive medicine could be used to remotely monitor the health condition of patients who had gone through a major operation. For instance, a person with a recent heart operation could leave the hospital earlier as the patient could be remotely monitored by a number of specialists whilst he/she recovered at home. A doctor could be instantly warned about any anomalies, such as a sudden change in the heart rate of the patient. This type of preventive tracking could also be used in chronically ill people to alert the doctor of sudden abnormalities, for instance low respiration rate for a patient with a respiratory condition, or alerting a patient with diabetes to take action before reaching any dangerous levels of sugar in the blood.

In addition to this, the integrated and concurrent monitoring of the environmental conditions can be a powerful tool for medical practitioners and researchers to aid in the findings of potential correlations between health problems and specific variables in the environment. Weather conditions can have a negative or positive impact in people with certain illnesses or health problems. As an example, a person with a recent eye operation should not be exposed to high levels of radiation from the sun or any other sources. Wireless sensors could detect these radiation thresholds and alert the patient. This example is also valid for certain skin diseases. Furthermore, for some people there are health issues related to a combination of atmospheric conditions, for instance some allergies or skin abnormalities occur when humidity, temperature and other levels of dust or pollen in the environment reach certain levels.

2.Problem Formulation

Many researchers are working on the concept of Body Area Network (BAN). The Mobihealth Project [5] allows patients to be fully mobile whilst undergoing health monitoring. CodeBlue[6] is a wireless infrastructure for deployment in emergency medical care. Another existing health monitoring system is

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Coach's Companion [7], which allows the monitoring of physical activity. However, the authors aim to extend real-time monitoring of patients by the use of a networking grapher tool called Multi Router Traffic Grapher (MRTG) [8].

MRTG can illustrate the potential correlations among different vital signs and specific changes in the environment. By having the vital signs and environmental conditions graphically displayed, it will be possible to make comparisons among them in an convenient and easy way, not only for the medical practitioners, but also for the patients and their families.

The graphical representation of patient case history is another advantage about Multi router traffic grapher. By having the patient problem details mentained in this format and ready to use, the process of establishing different hypotheses about when and why these anomalies happen could be accelerated.

For example, it might be noticed that some people tend to get a specific illness in a time of the year, by checking the time evolution of some health parameter.

On the other hand, it can be applied to sports players for knowing the time of the year when they obtain better results in the competition [9].

3. Architecture and project desires

The desire of our project is the building of a whole mobile system solution that will allow medical practitioners the remote monitoring of the patient's state in real time.

The system has been based on an existing network monitoring tool: MRTG.There does not yet exist a flexible, robust communication infrastructure for supporting this application.

Therefore, we propose an efficient and secure wireless communication framework, which can be considered highly reliable for transmitting critical data, as well as an integrated data protection system. The general architecture of the project can be seen in Figure 1 and is explained in the following sections.

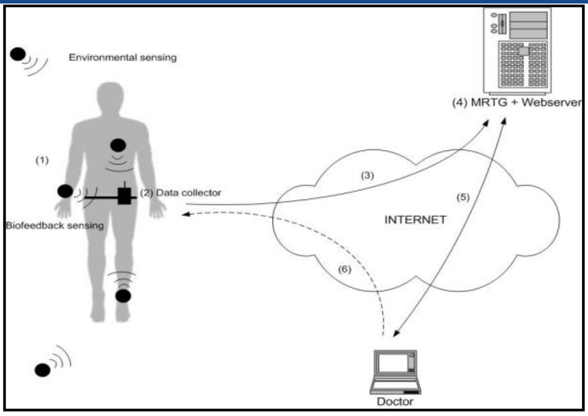

Figure 1 System Overview

a).Wireless Sensor Network.
The lowest level of the architecture proposed consists of the sensor nodes which provide physical access to vital signs and environmental parameters. These devices are placed in areas of interest, and collect data primarily about its immediate surroundings. The motes could be used to monitor body temperature, heart rate and pulse rate, as well as many other parameters. Different versions of the basic design are being developed, but the authors will focus on the MICA2 Mote whose most interesting technical aspects are [1]:

7.7 MHz processor.

- Atmel ATMega 128, with 2 serial ports.
- Over-the-air programmable.
- Radio: tunable FM.
- Frequency: 315 or 433 or 915 MHz.
- Data rate: 38 Kb encoded
- 512 KB on-board flash.
- Unique ID.

Figure 2 Motes and sensor boards [www.xbow.com]

In the future, the authors will implement the 3rd generation motes, namely Mica2Dot [3], very similar to the MICA2, except for its quarter-sized form factor and reduced i/o channels. The significantly smaller size of the Mica2Dot make it best suited for commercial deployment. The Mica2Dot motes are simple to adapt to wearable devices, such as those to be used in a Body Area Network.

The most significant feature is that devices consume roughly 20mA when active resulting in a battery lifetime of 5-6 days if continuously running.

They can drop to a very low power sleep state of 10μA, increasing life time to over a couple of years.

In general, applications will employ duty-cycling to achieve good lifetime limitations with reasonable communication and computation rates. However it depends on the parameter being sensed:

- In parameters that do not change suddenly, one reading every minute will be enough: temperature, humidity or level of sugar in blood.
- In parameters that may alter in a short period of time, the readings will be done very often, for example, each 10 seconds. In this group, the level of light, heart rate or blood pressure could be included.

Compared with traditional data logging systems, networked sensors offer two major advantages [10]: they can be re-programmed "in-situ", and they can easily communicate with the rest of the system. "In-situ" re-programming allows the scientists to refocus their observations based on the analysis of the initial results.

For example, if some heart-rate trouble is detected in a certain patient, doctors could be able to change the sensing rate by increasing it. The great advantage is that sensors typically form a multichip network by forwarding each other's messages, which vastly extends connectivity options.

This is very useful when some motes are not in the coverage area of the base station, and communicate with neighbour motes to reach the base station.

These devices run a specialized operating system called TinyOS[11]. This tool has been specifically developed to manage all the operations related to the motes. The Tiny OS system, libraries, and applications are written in nesC[12], a new language for programming structured component-based applications. The nesC language is primarily intended for embedded systems such as sensor networks. nesC has a C-like syntax, but supports the TinyOS concurrency model, as well as mechanisms for structuring, naming, and linking together software components into robust network embedded systems.

b) Sensor Boards.

To provide relevant measurements to the doctors, we need as many sensors as parameters we wish to monitor. For our experiments we used the Crossbow Professional Development Kit MOTEKIT 5040 [13], which only includes light and sound sensors, so our tests have been limited to these measurements. An example of a sensor board is shown in Figure 4.

c)Data collector.

Data from each sensor need to be propagated to the Internet. The data collector is the equipment in charge of retrieving all the data from the smart tags, interpreting them, and forwarding to a remote server via Internet, in order to make them available to the final user.

The main elements of this subsystem are, on one hand, a base station mote, which will establish a communication with all the other motes, receiving all the readings.

On the other side, a handheld device, or PDA, will work as a gateway between the motes and the Internet. The connection between the base station mote and the PDA may be wired or wireless.

Smart tags have their own radio protocol which means that they cannot establish any wireless communication with other devices except other motes. Consequently, all the data to be sent over the air using other protocols must be firstly redirected to another device that supports that protocol.

The operation is as follows: all the motes are sensing the vital signs and the environmental parameters, continuously sending the data to a base station mote using their own protocol. This mote has a TinyOS application running all the time, which listens for the data from all the sensors, and forwards it through the serial port. However, motes do have not DB9 connectors for serial communication so the solution is to attach the base station mote to the programming board, and use its serial port.

The MIB510CA programming and serial interface board is included in the MOTEKIT5040 [13]. Any MICA2 node can function as a base station when mated to the MIB510CA serial interface board, which provides an RS-232 serial connector. The DB9 connector may act as the gateway for connecting the wireless sensor network to the "external world", that is, for holding communication between motes and other devices.

The other component of the data collector is the PDA. The handheld device, which can run both Linux and Windows, will run a Java application for gathering the data from the motes, processing them, and sending the result to the MRTG server. The main features of the Java application operation are:

- Gathering the raw data from the serial port.
- Extracting the needed information from the data, like readings, group and mote ID, type of messages.
- Formatting the data in some understandable way by MRTG. XML is a very good option, because of its platform independent nature.
- Finally, sending all the data to the MRTG server using Wireless LAN, GPRS or UMTS.
- The PDA will display the created graphs in HTML in real time.

d.Implementation Problems

In settting up our testbed (See Figure 3) we encountered several problems**.** The Base Transceiver Station (BTS) is composed of the programming board with serial port (MIB510) and a MICA2 controller connected on it with radio communication and power supply (two AAA batteries) features. The other MICA2 controllers are directly connected to the sensor boards (MTS310) and via radio frequency (ISM 916 MHz) to communicate. The Bridge Transceiver Unit (BTU) is the point of connection between the sensor network and the BAN.

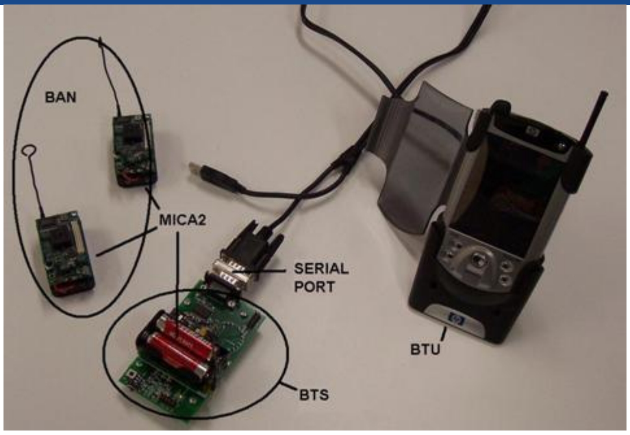

Figure 3 BTS/BTU connection [www-staff.it.uts.edu.au/~messina]

We encountered several problems in establishing communications between the pda and base station mote.1st proposal was to use Bluetooth via a serial to Bluetooth adaptor, in order to send wirelessly the raw data from the programming board to the PDA. However, this adaptor needs to be supplied by the device to which it is attached and, in this case, the programming board has not enough power to achieve it.

Finally, we decided to use a serial connection (DB9), based on the RS232 protocol. The PDA did not have a DB9 connector, but there was expansion pack available (see figure 6), so we acquired a PCMCIA - to- serial adaptor.

Further commodity based hardware issues emerged when we found that the wires on the adapter were incorrectly twisted and had to be re-arranged.

Figure 4 Ipaq Expansion Pack [www.compaq.com]

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Figure 5 PCMCIA to RS232 Adapter

e)Server.
The core of the Body Area Network surveillance is the tool Multi Router Traffic Grapher[8]. MRTG is a tool to monitor the traffic load on network links. MRTG generates HTML pages containing graphical images which provide a live visual representation of this traffic. MRTG is written in Perl and C and works under UNIX and Windows NT.

The basic operation of MRTG is based on Simple Network Management Protocol [14]. This protocol has become the “de-facto” standard for internet-work management, and includes a limited set of commands and responses to a Management Information Base (MIB), hierarchical information, structured as a “tree”. So, MRTG uses the information provided by SNMP to obtain graphics of the different parameters contained in the MIB, such transmitted or received packets, discarded packets, CPU usage, amount of free memory and data rate.

f)MRTG as a BAN Tool

The device being monitored normally supports the SNMP network management protocol, but MICA2 motes do not support this protocol. MRTG is able to support non-SNMP enabled devices by creating a personalized script that would do the readings or polling of information instead of using the SNMP protocol.This makes MRTG a flexible and powerful tool way beyond its use as a network management tool alone.

The authors personalized a way of adapting MRTG for working with non-SNMP devices by running a script that captures the required data from a source and implements the translation to SNMP format. The source is a text file which is the output of the Java application in patient’s PDA. When this file arrives to the MRTG server, the script will open it, extract required data, format into SNMP protocol, and pass it to MRTG.

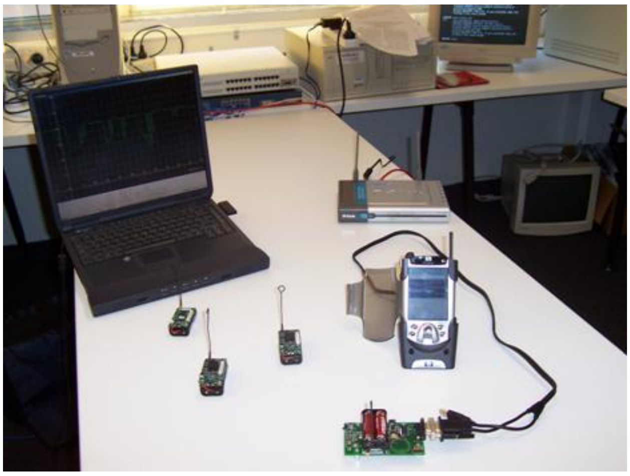

Figure 6 – Testbed set up

Another issue to be discussed is how the files will be transferred from the PDA to the MRTG server. At the Astrophysics Institute of Canarias scientists are using MRTG to monitor weather conditions. The data is gathered every fifteen minutes from the weather station at the Teide Observatory, and then is passed by File Transfer Protocol to the MRTG program which generates the graphs.Once the readings are captured by MRTG, it starts to generate the different graphics. There are several different graphics, depending on the monitored period of time: daily, weekly, monthly, yearly. In our experiments we captured light readings as proof of concept. Every time MRTG captures another measurement, all files are updated. Several patients can use the service at the same time. So, it seems evident the need of a database for storing all the health data related to each patient in a structured way. We propose the use of PostgreSQL[15], a free and open source database.

These final files that contain the graphics will available for remote web access. In consequence, a web server is needed for allocating them. We will use Apache 2.0 [16] which is not a web server, but an application server. It means that it can support web sites with additional features, such as database interaction and dynamic content generation, as well as different operative system, Perl, PHP, SSL, authentication and access control.Apache will be in charge of allowing MRTG to publish the graphs into a website in real time.

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The authors believe that MRTG provides the system of a way for publishing in a website all the health and environment parameters sensed by the wireless network sensor in form of graphics.

g)Remote Access.

Once the whole system has been set up, a remote user, usually a doctor or even a relative, will have complete access to the data stored in the web server by MRTG. There are only two requirements to be carried out:

- The remote user needs an internet browser. It is one of the most promising features of this platform: no additional software or previous knowledge about the use of the tool is required. It is assumed that the doctor or the remote user is confident with internet navigation.
- To prevent non-authorized users from accessing the system, a client digital certificate will be required in the HTTP connection. In this way, only the users with valid certificates will be able to consult the health data of a patient.

The main webpage could be a form, in which the remote user can type the name or ID of the patient to be monitored, When the web server receives the request, it automatically starts a query to the database based on the information contained in the form, in order to extract the graphs related to the solicited patient. These graphs will finally be displayed in the user's browser. For achieving a real time system, the web site must be refreshed the same period of time as MRTG generates a new graphic

Possibly, the best feature of our platform is that it is completely user-friendly, in the sense that no previous knowledge or training is needed; any individual with minimum knowledge about computing is able to use it.

4.Conclusion

In this paper the authors have discussed a health monitoring "out-of-hospital" conditions system, aimed to save lives, create valuable data for medical research and cut the cost of medical services. Using an existing monitoring network tool, namely MRTG, we have proposed an infrastructure for recording environment and biological variables, in order to achieve a remote, reliable, secure and efficient real-time access to this data.

1st, we have discussed how a body area network can be developed using tiny, smart and low-cost tags, forming the collection of wearable sensors that monitor patient's health, as well as the environmental sensors in charge of measuring weatherconditions.

To achieve this system much more than just sensors are needed. We have attempted to set up a prototype system using commodity based hardware which has caused many problems which we have overcome. A complete health monitoring system is required. We have proposed a whole system for providing healthcare and wellness or disease management. In this way, MRTG represents a very useful tool for drawing and publishing in a website all the raw data captured by the sensors. A handheld device, usually PDA and a base station mote, will act as the gateway between the physical parameters and MRTG, being in charge of gathering the raw data from the sensor network, formatting it and sending to the MRTG server. With this, we have demonstrated that motes can be integrated with other existing tools, improving their features.

Future research involves how to provide the entire infrastructure with secure and reliable communications using TinySec[17], and the use of digital signatures for providing health information with legal properties. Other issues that will form the basis of further research are: Devising algorithms to clean up the enormous amounts of data coming from the motes; ensuring that the medical data remains private; obtaining more medical sensors to interface with the Motes and ensuring that the devices are really wearable.

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