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Remote Monitoring Using Wireless Cellular Networks

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Abstract.

Remote sensing and alerting exists from long time and it has been under focus to improve the quality of sensing and alerting from long time. Due to major technology innovation in communication and wireless sensor technology, it made possible for common man and business magnets to use this technology to their industries. This research proposes value added service model to an existing model QMeter™ to exploit the same model for remote monitoring for other industries. QMeter™ is used for monitoring and alerting and call quality and bandwidth quality for mobile operator in particular. This particular research uses the same model and utilizes the short message service of the mobile operator as a part of VAS service to remotely monitor, alert and provide the reports.

Keywords: *Remote Monitoring, GSM Gateway, Call Quality, QMeter™, Cellular Network*

1. INTRODUCTION

Industrial businesses are looking for readymade laid out networks and resources to be utilized to cater their needs of remote monitoring. Human monitoring is obsolete and no longer is being considered better option. In Agriculture sector, the critical role for the farmers to monitor 24 hours to some critical plants such as vegetable, flowers and some consumable items made this remote monitoring the better option. In agriculture sector, there is scope of risk and it further increases with the increase in the farming area and it is also time consuming and tedious.

The penetration of cellular network in the rural areas made this remote monitoring better option. Hence remote monitoring can be applied to agricultural sector and easily feasible. This proposed design utilizes wireless sensor network, Global System for Mobile Communication (GSM) and short message service (SMS) to carry out data from the sensors to computers or directly alert the workers through their mobile phone. This proposed design will eliminate the wired technology and improves the method of alerting and collecting data in farming areas on time.

Advanced monitoring and control systems are increasing due to the availability of cheaper and pervasive components such as processors and hardware in the current market. The trend is moving towards wireless solutions due to an increased interest in it as compared to the current wired-based systems [1]. In addition, modern wireless technology can very much improve the efficiency of data collection and agriculture techniques, as compared to the traditional time consuming and labor-intensive manual practices [2].

The current agriculture monitoring devices have two main drawbacks, which are less user-friendly and costly. To overcome these, there is a need for easy-to-use and less costly devices for agriculture monitoring activities [3].

The system to alert farmers regarding the temperature changes in the greenhouse so that early precaution steps can be taken in advance is proposed in [4]. Tests conducted in [4], prove the viability of the system and indicated that the reliability of the system in propagating information directly to the farmers could be gained excellently in various conditions.

This research in [4] focused on the study on remote monitoring system in greenhouse which has capability of sending alert notification messages to farmers using GSM and SMS technology and is aimed to be a reliable and cost effective. There are a lot of technologies that have been created to perform the operation; however, many of the existing technologies would still require a great deal of human intervention.

All the current technologies for remote monitoring detect and alert using wired technologies, but the proposed design not only alert and detect the change in thresholds it removes the distance criteria and labor to deploy the system and its maintenance. The proposed system can store and forward the information to the end user for

forecasting and analyzing the historical data. Apart from general remote monitoring, mobile operators are very much in need to monitor the call quality as perceived by the end-user. The mobile equipment with an application installed can be used as sensor to collect and monitor the call quality. The proposed design in this paper in embedded in QMeter™ system, which has both call quality monitoring module and general purpose remote monitoring that can be used for green house and any other businesses that requires critical remote monitoring.

This paper presents the generic model of wireless monitoring and call quality monitoring in particular from the mobile operators perspective. This particular model presented is in continuation of the work published in [5][6][7][8][9][10][11][12][13][14].

2. A MODEL FOR GENERIC REMOTE MONITORING

Vendors that provide value added services products differ in their design and usage of the technology. The model proposed utilizes the short codes that are used for other kind of value added services such as mobile advertising and marketing. In this particular model for remote monitoring, the biggest challenge is to integrate the sensor with the GSM gateway. Since the GSM gateways are the major hindrance to the network call quality and bypass gateway frauds, the operator need to scrutinize the use by differentiating the legal and illegal use of gateways.

The below Figure 1 depicts the overall design of the model of the site being monitored and cellular network. It involves the sensor and the gateway embedded with subscriber identity card.

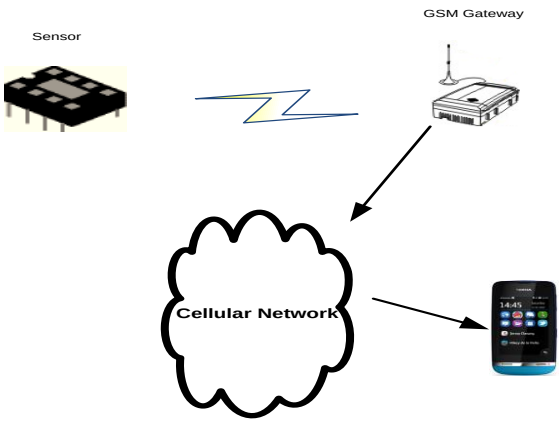

Figure 1: Remote Monitoring Model

If the data that needs to be sensed and shared remotely is huge, the GPRS technology and multiple sim gateways can be used. For the small information sharing and only at certain intervals of threshold breach etc., which doesn't involve huge information, short message service can be used and this model focuses on this kind of remote monitoring. In the below Figure 1, the sensor is anything that has the ability to sense the required information continuously and send the alert to the gateway. The GSM gateway functions as router for this information sent by the sensor to the pre-configured number in the form of short message service.

3. QMETER™ MODEL FOR REMOTE MONITORING

QMeter™ model addresses the issue of call quality from of cellular network from end-users perspective. The model is extended to incorporate any remote generic monitoring. This model can be used to get critical environmental agriculture data such as temperature, humidity and irrigation from real source to achieve improvement in agriculture production. The real source can be any sensor that is feasible and appropriate for his need. This model can be used by farmers to predict and evaluate environmental impacts and turning waste into revenue.

The main part of the QMeter™ is call quality monitoring parameters and its sharing with the operator. We present here the parameters used in this calculation. The parameters are calculated at the end-user equipment and shared through the model presented.

The basic parameter that has been considered is the signal strength, which has been measured for every 5ms of an active call. The signal strength is measured for every 5ms and logged, if there is change in the signal strength information. The signal strength classification is based on the below Table 1. The average signal strength is calculated at the end of the call.

Table 1: Signal Strength Classification

Signal Level Range (dBm)	Classification	Score
-120 to -95	Extremely Bad	1
-95.00 to -85.00	Bad	2
-85.00 to -75.00	Average	3
-75.00 to -65.00	Good	4
-65.00 to -55.00	Very Good	5

The calls were classified as successful and un-successful call attempts based on whether the call is successfully connected to the network. The successful attempts are again classified as normally dropped and dropped due to handover, which are the calls dropped during the cell change.

The call statistics for the bundle of 10 calls are considered for all the parameters. The successful call rate score is calculated based on the number call successful call attempts made for every 10 calls based on the below Table 2.

Table 2: Successful Call Attempts Score

Successful call Attempts	Score
1-2	1
7-8	2
5-6	3
3-4	4
1-2	5

The normal dropped rate score is classified based on the below scale in Table 3.

Table 3: Normal dropped rate score

Normally dropped rate	Score
< 4	1
>4 & <6	2
>6 & <7	3
>7 & <8	4
>8	5

The average signal strength for all the successful calls is calculated together with successful call attempts score and normal dropped rate score for the bundle of 10 calls. The call quality is derived from the scores computed as:
(Average signal strength score of all successful calls + successful call rate score + normal dropped calls rate score)/3. The final call quality for the bundle of 10 calls is classified according to the below Table 4.

Table 4: Call Quality Score

Score	Classification
<1	Extremely Bad
1 - 2	Bad
2- 3	Average
3- 4	Good
4 - 5	Excellent

The call quality parameters computed on the mobile equipment of the end-user. Together with these parameters, the GPS coordinates and cell-id information at that particular location of the user is retrieved and shared with the call quality to the QMeter™. The parameters and other information computed at the end-user is sent to the remote QMeter™ application via SMS to short code. The shortcode for this application is allocated by the mobile operator to which we are sharing this information. The information collected at the QMeter™ system sent through the mobile equipment's through different parts of the network covering the entire operator's network. The QMeter™ application will retrieve and store the information collected in the database and would be available to the operator in hand, which would be very helpful to analyze the call quality for benchmarking and addressing other issues related to call quality. The cellular operator can generate the reports based on different parameters such as cell id's or GPS coordinates and the parameters that need to be benchmarked. This would be very helpful for any cellular network operator to improve the call quality wherever needed. A generic block diagram depicting the flow of call quality from mobile equipment to QMeter™ Application is shown in Figure [5]. The same system QMeter™ in Figure is extended to incorporate and any other remote parameters in the same way as call quality collection. It integrates the generic remote monitoring system that can be used for any other industry purpose such as greenhouse monitoring, temperature monitoring etc. On the other hand, the cellular operators can make other local information such as weather related data available to the site through local BTS. The QMeter™ can extract such data in a manner similar to what has been demonstrated here. The local information augmented with the farmer own sensors data can then be made available to the farmers to make the right decisions. By providing localized real time weather related data without having to build any portal or a back end host will even replace farmers own local weather station. One local BTS weather station service without any back end hosting or infrastructure, which does not even require any data link because will QMeter™ will communicate with the BTS and get the local weather data directly. The remote monitoring of any industry need can be commercialized and easily exploited as a value added service provide by the cellular operators, which is very good revenue generating opportunity.

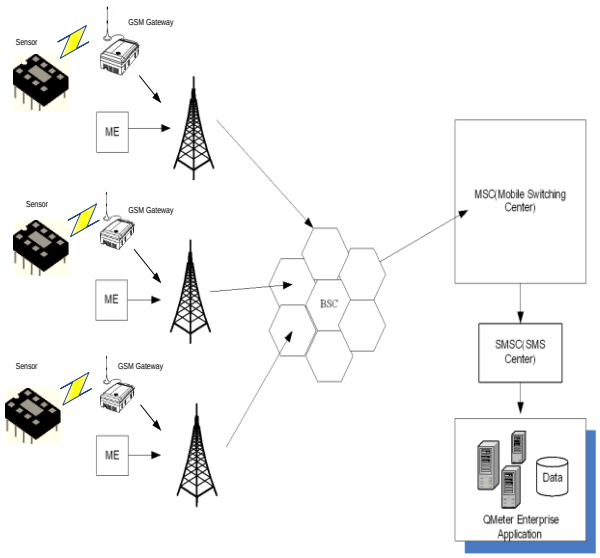

Figure 2: QMeter™ Model for Call Quality and Generic Remote Monitoring

4 SIMULATION RESULTS FOR CALL QUALITY

We presented the simulation results of parameter calculations; GPS coordinates marking on the map of the end user with the call quality parameters. Figure: 3 and Figure: 4 contains the landmarks of successful calls with colors in green and red showing the normally and handover dropped calls. The results logged in the end-user equipment are also presented in this section.

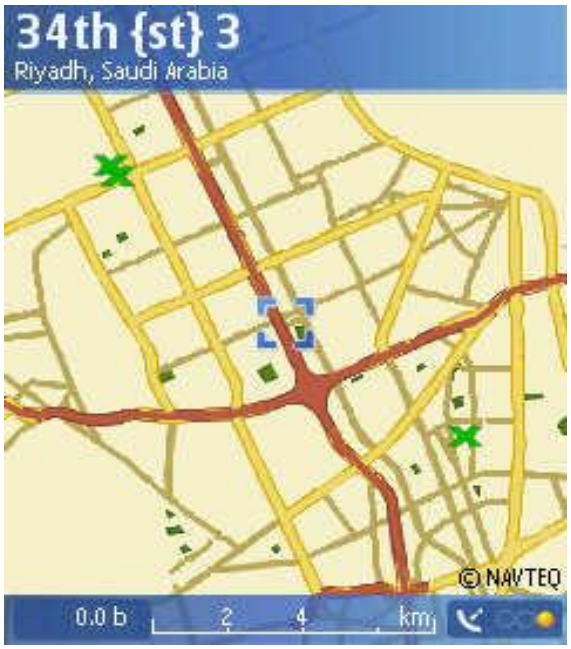

Figure: 3

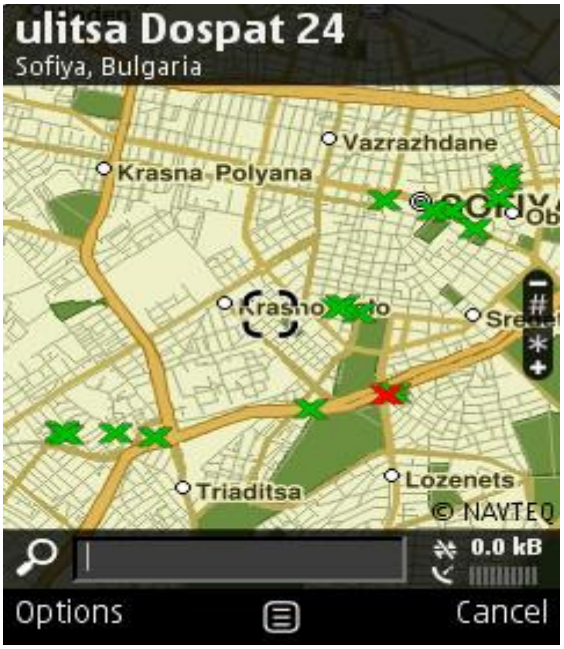

Figure: 4

Parameter logs:

2012/08/26 - 12:20:32 : : Current network info LocationAreaCode = 352 CellId = 12211
2012/08/26 - 12:20:36 : : Signal strength is = 80 dBm, 7 bars
2012/08/26 - 12:20:58 : : Signal strength is = 83 dBm, 7 bars
2012/08/26 - 12:20:59 : : Signal strength is = 82 dBm, 7 bars
2012/08/26 - 12:21:07 : : Signal strength is = 77 dBm, 7 bars
2012/08/26 - 12:21:12 : : Signal strength is = 81 dBm, 7 bars
2012/08/26 - 12:21:44 : : Signal strength is = 79 dBm, 7 bars
2012/08/26 - 12:21:46 : : Signal strength is = 82 dBm, 7 bars
2012/08/26 - 12:21:47 : : Signal strength is = 78 dBm, 7 bars
2012/08/26 - 12:21:49 : : Call drop observer -> Event : Call state is changed. Phone status: Idle
2012/08/26 - 12:21:49 : : Average signal strength is 80 dBm (Average)

Sample Call Statistics

2012/08/29 - 07:45:33 : : 0 call attempts failed
2012/08/29 - 07:45:33 : : 10 call attempts successful :: Score: 3 (Average)
2012/08/29 - 07:45:33 : : 10 calls was normally dropped :: Score: 3 (Average)
2012/08/29 - 07:45:33 : : **********

5 REFERENCES

[1] George W. Irwin, Jeremy Colandairaj and William G. Scanlon, "An Overview of Wireless Networks in Control and Monitoring", *International Conference on Intelligent Computing, Kunming , CHINE (2006)*, Vol. 4114, 2006, pp. 1061-1072.

[2] Tseng Chwan-Lu, Jiang Joe-Air, Lee Ren-Guey, Lu Fu-Ming, Ouyang Cheng-Shiou, Chen Yih-Shaing and Chang Chih-Hsiang, "Feasibility study on application of GSM–SMS technology to field data acquisition", *Computers and Electronics in Agriculture*, Vol. 53, Issue 1, 2006, pp. 45-59.

[3] S. Correia, V. Realinho, R. Braga, J. Turegano, A. Miranda, J. Ganan, "Development of a Monitoring System for Efficient Management of Agriculture Resources", *Proceeding of the VIII International Congress on Project Engineering*, 2004.

[4] Izzatdin Abdul Aziz, Mohd Hilmi Hasan, Mohd Jimmy Ismail, Mazlina Mehat, Nazleeni Samiha Haron, "Remote Monitoring in Agricultural Greenhouse Using Wireless Sensor and Short Message Service (SMS)", *International Journal of Engineering & Technology IJET* , Vol: 9 No: 9

[5] A. Aburas, k. Al-Mashouq, "A Model for Call Quality Computation and Collection in Mobile Telecommunication Network," *International Journal of Advanced Computer Science, Jan-2011.*

[6] Akram Aburas, J. G. Gardiner and Z. Al-Hokail, "Symbian Based Perceptual Evaluation of Speech Quality for Telecommunication Networks," *The 6th International Conference on Computing, Communications and Control Technologies*: *CCCT 2008*, Orlando, Florida, USA.

[7] Akram Aburas, J. G. Gardiner and Z. Al-Hokail, "Perceptual Evaluation of Speech Quality-Implementation Using a Non-Traditional Symbian Operating System," *Accepted for publication in the 5th IEEE-GCC Conference on Communication and Signal Processing*: *IEEE-GCC March 17 – 19, 2009,* Kuwait City, Kuwait.

[8] Akram Aburas, J.G. Gardiner and Zeyad Al-Hokail, "Emerging Results on symbian based perceptual evaluation of speech quality for telecommunication networks," *CCCT 2009*, Orlando, Florida, USA

[9] Akram Aburas, Professor J.G. Gardiner and Dr. Zeyad Al-Hokail, "Transitional Results on Symbian Based Call Quality Measurement for Telecommunication Network," *ICPC 2009*, Taiwan.

[10] Akram Aburas, Professor J.G. Gardiner, Prof Khalid Al-Mashouq and Dr. Zeyad Al-Hokail, "Results of Ongoing Symbian Based Call Quality Measurement for Telecommunication Network," *Telfor 2009*, Belgrade.

[11] Akram Aburas, Professor J.G. Gardiner and Dr. Zeyad Al-Hokail, "Call Quality Measurement for Telecommunication Network and Proposition of Tariff Rates," *CCCT 2010*, Orlando, Florida, USA.

[12] Akram Aburas, Professor J.G. Gardiner, Prof Khalid Al-Mashouq and Dr. Zeyad Al-Hokail, "Perceptual Evaluation of Call Quality and Evaluation of Telecom Networks," *STS-2010* Conference, Riyadh, KSA.

[13] A. Aburas, K. Al-Mashouq, "Call Quality Measurement and Application in Telecommunication Network," Cyber Journals: Multidisciplinary Journals in Science and Technology, *Journal in Selected Areas of Telecommunication (JSAT)*, May – 2011.

[14] A. Aburas, K. Al-Mashouq, "QMeter Tools for Quality Measurement in Telecommunication Networks" *International Journal of Computer Networks & Communications, Wireless & Mobile Networks*, June –