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UPGRADING OF REAL-TIME RADIATION DATA LOGGING AND WEB BASED RADIATION MONITORING SYSTEM

Mohd Fauzi Haris[1], Saaidi Ismail[1], Mohamad Safuan Sulaiman[1], Mohd Dzul Aiman Aslan[1], Siti Nurbahyah Hamdan[1], Maslina Mohd Ibrahim[2] and Nolida Yussup[2]

[1]Information Technology (IT) Center,
[2]Instrumentation & Control Center,
Technical Service Division,
Malaysian Nuclear Agency,
Bangi, 43000 Kajang, Selangor, Malaysia.
Correspondence author: fauziharis@nuclearmalaysia.gov.my

ABSTRACT

The remote measurements of radiation level at an identified location, are not only important for collecting data or monitoring radiation level per se, but also crucial for workers who deal with radiation sources. A device for checking an on-site radiation level has been developed quite a long time ago under the name of Geiger Muller and widely known as a Geiger counter. The reading of the output can be seen on the device on-site and on real-time basis. Nowadays, with the fast evolution of computer and networking technology, those reading not only can be read real-time but also from a remote location that makes workers able to enter the risky area more safely. The collected data reading also can be analyzed for predicting the future trending pattern. The data is transferred from the monitoring devices to a server through a network. This paper discusses about several critical issues on the design, implementation and deployment that relates to the devices, interface programs, hardware and software that allow all parameters such as radiation levels reading and the timestamp of the data-logging can be collected and stored in a central storage for further processes. The compatibility issue with regards to technology change from the previous system will also be discussed. The system has many advantages compared to previous system and conventional method of doing the area monitoring in term of sustainability and availability.

Keywords: Availability**,** Geiger Muller, radiation area monitoring, radiation level, sustainability

INTRODUCTION

A sensor is a sophisticated device that receives a stimulus and responds with an electrical signal (Fraden, 2010). It is essential components in many applications, not only in the industries for process control but also in daily life for buildings safety and security monitoring. In nuclear facility, the monitoring of a wide range of variables with respect to safety and security has become much more important. For radiation area monitoring, it is very important to check if there exist any radiation leakage in data reading of the area. This is paramount to assess the workplace condition for the safety of the workers who work in either controlled area or supervised area. In order to follow the concept of 'As Low As Reasonably Achievable' (ALARA), thus sensors has always been given the task for doing so.

Advancement of sensors, computer and networking technology and the combination of those three main components for data acquisition system has proved to be a better approach for radiation area monitoring to follow the concept of ALARA. Commercial solutions which are also available, however, are quite expensive and complex in nature as some of them require a dedicated and proprietary system and equipment.

The proposed system for upgrading has been divided into three main components which are: (1) sensors and data collector, (2) data storage and (3) data display. Figure 1 showed the block diagram of the overall system in the existing network infrastructure. The sensor and data collector system that currently used in the agency is a Ludlum 375/2. The Ludlum 375/2 is a digital electronic controller designed for monitoring radiation areas; meanwhile, the ICP CON I-7188E is a module for transferring data between the data logger (Ludlum) and a server. Server is used as it is designed to manage, store, send and process data more reliable under high load for years and the system has a robust features desktop computer.

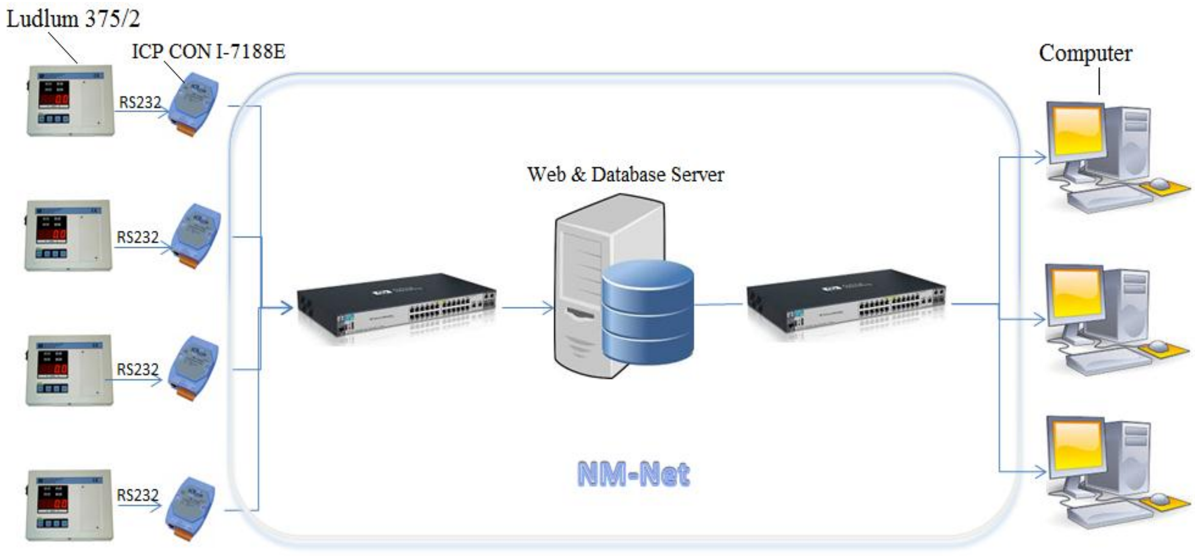

Figure 1: Block diagram of the radiation area monitoring system

This paper aims to present our way of developing a low-cost, yet reliable and sustainable of a radiation area monitoring system that capable of acquiring, recording, storing, and displaying data on a real-time basis.

MATERIALS AND METHODS

Sensors and Data Collector

The two major hardware components of sensors and data collector are the Ludlum sensor and the DataConn – Xserver. The Ludlum sensor (Figure 2) is used for the Geiger–Müller (GM) Counter and it comes with a number of good extra features. Some of the optional features are:

i. Ludlum's Webpage and Service Software
ii. Capture a picture of whatever triggered an alarm
iii. Link multiple 375 systems together via Ethernet
iv. Send intelligent email alerts to responsible personnel

However, those options come with extra budgetary. Therefore, our objective is to develop a ‘customize able’ and a low cost area monitoring system.

Figure 2: Ludlum 375/2 as an area monitor controller

Meanwhile, the DataConn – Xserver was developed to have a capability to receive and read data from any custom device for RS232 (Figure 3) to Ethernet converter (Akpan et al., 2013). This becomes one the uniqueness of the developed system. Future new installation will be using ADAM-4571L which has lower cost. Further R&D is in progress to build a custom made RS-232 to Ethernet converter combined with area monitoring sensor in one device.

(a) ICP CON I-7188E1 (b) ADAM-4571L

Figure 3: The data connectors for converting data from RS-232 to Ethernet Port

Furthermore, the most important software for use in the area monitoring system is: (1) the GM-Xserver interface and data collector, and (2) the Web Interface. In this work, we tried to install a VB6 on the latest computer machine even with Microsoft Operating system such as Windows 7 and Windows 8 installed. In the installation process, we had written an alternative script in Python programming language to handle data collection from the serial server. Simple test has been done to ensure Python following task to collect data from the serial server in both Windows and Linux environments (Figure 4).

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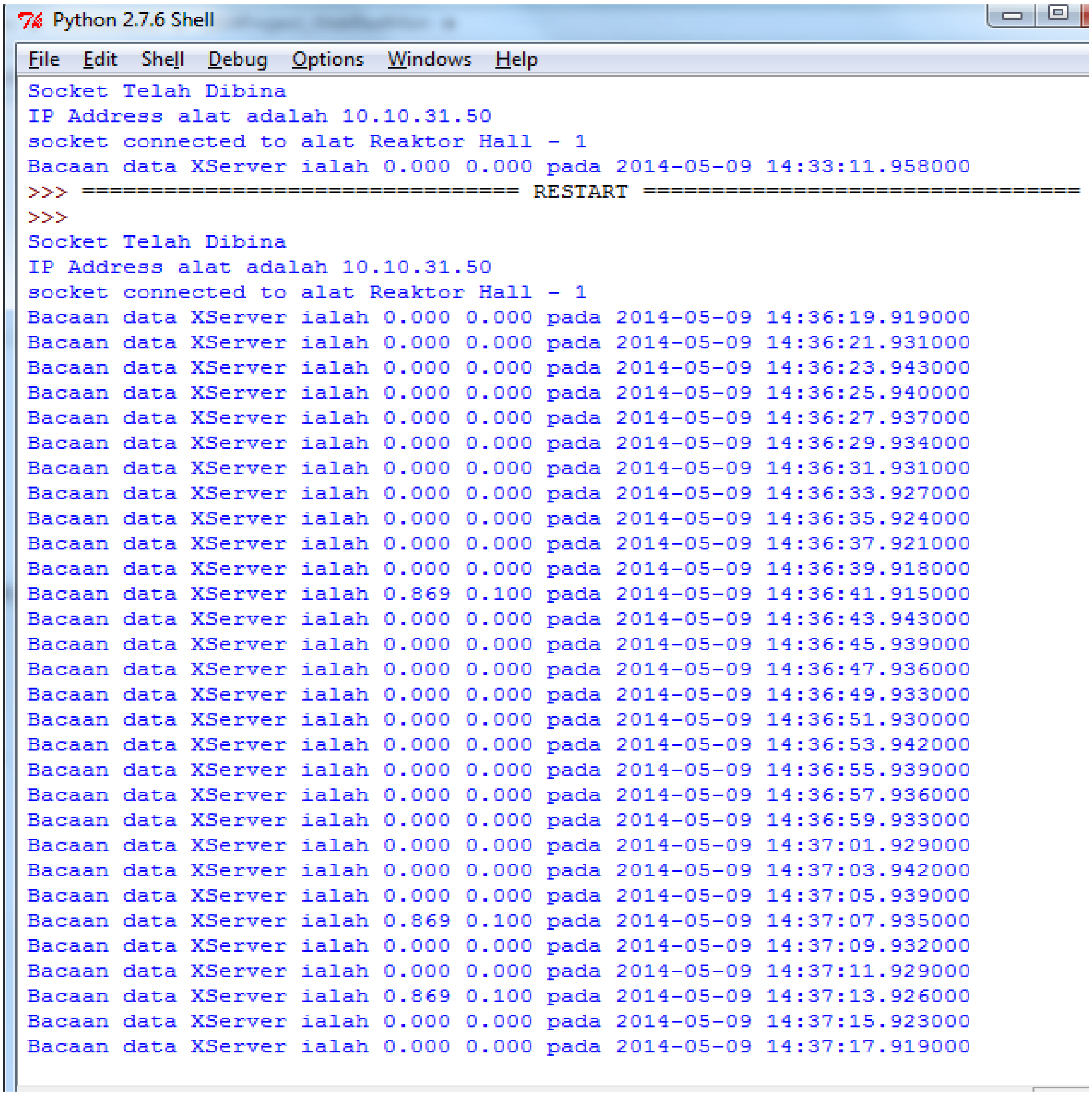

```
Python 2.7.6 Shell
File Edit Shell Debug Options Windows Help
Socket Telah Dibina
IP Address alat adalah 10.10.31.50
socket connected to alat Reaktor Hall - 1
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:33:11.958000
>>> ================================ RESTART ================================
>>>
Socket Telah Dibina
IP Address alat adalah 10.10.31.50
socket connected to alat Reaktor Hall - 1
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:19.919000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:21.931000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:23.943000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:25.940000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:27.937000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:29.934000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:31.931000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:33.927000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:35.924000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:37.921000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:39.918000
Bacaan data XServer ialah 0.869 0.100 pada 2014-05-09 14:36:41.915000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:43.943000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:45.939000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:47.936000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:49.933000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:51.930000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:53.942000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:55.939000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:57.936000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:36:59.933000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:37:01.929000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:37:03.942000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:37:05.939000
Bacaan data XServer ialah 0.869 0.100 pada 2014-05-09 14:37:07.935000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:37:09.932000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:37:11.929000
Bacaan data XServer ialah 0.869 0.100 pada 2014-05-09 14:37:13.926000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:37:15.923000
Bacaan data XServer ialah 0.000 0.000 pada 2014-05-09 14:37:17.919000
```

Figure 4: Simple test result using Python

Moreover, the web interface provided users on the data readings. It is offer simple, intuitive and responsive user interfaces that let their users get things done with less effort and time. In developing the web interface, a few important informations need to be considered and displayed informatively such as:

i. List of person-in-charge of all listed locations
ii. Information and meaning of all read data
iii. Standard Operating Procedure in the occasion of over threshold data reading
iv. Plan location of all sensor devices

Since the data is displayed and refreshed for every 2 seconds (Figure 5), consideration should be given to ensure the displayed data is correct and should be supported by all or most browsers. Attractiveness of the web interface design is also an important aspect that needs to be taken care of. We are thinking of developing the new web interface using Hypertext Preprocessor (PHP) for 2 reasons:

i. Ease of portability – can be put in Windows and Linux environment
ii. Availability of existing scripts to be customized to suit with the system requirements

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```
<?php
$myfile = fopen("/var/www/html/radmon/Script/Loc_RxHall2.txt", "r") or die("Unable to open file!");
echo fgets($myfile);
fclose($myfile);
echo "<meta http-equiv='refresh' content='2'>";
?>
```

Figure 5: Simple PHP script to display data for every 2 seconds

Data Storage

There are several conditions which need to be studied in order to deploy suitable data storage for this system. The foremost condition, monitoring data can be viewed and captured in real time manner. Inline to that, data integrity and data availability cannot be compromised to ensure the system functionality.

The second condition that should be considered is data preservation. As stated in Radiation Protection Program document that has been approved for Nuclear Malaysia by Atomic Energy Licensing Board (AELB), monitoring data that has been collected need to be preserved for at least two (2) years (Nuclear Malaysia, 2014). Based on these conditions, dynamic, robust and reliable data storage should be considered in order to comply with this requirement. Criteria such as data storage capacity and processing power also need to be considered to fulfill these conditions. Based on the system requirement, detailed calculation has been made to provide the ideal storage capacity needed for the system implementation as described in Table 1 below. Simple mathematical notation of required storage (in bytes) per day can be calculated following the Equation (1).

$$Storage = \sum_{n=0}^{17} \left(\frac{60}{s}\right) m.h.b \qquad (1)$$

Where:

n is the number of sensors,
s is the number of time interval for data collection per minute,
m is the number of minute per hour,
h is the number of hour per day,

Table 1: Data storage calculation for web-based radiation monitoring system

Description	Monitoring Data	
No of monitoring devices	17 unit	
Data transmission frequency	2 seconds	
Size of data transmitted	14 bytes	
Number of data per day	43200 data	
Number of days in a month	31days	
Number of days in a year	365days	
Total Storage Required / Month	1339200 bytes	1.277Mb
Total Storage Required / Year	15768000 bytes	15.04Mb

b is the number of bytes for each data.

Data Display

Besides displaying the collected data on the web interface, another 2 options that already in planning for future expansions of the system:

i. Graphite – Scalable Real-time Graphing (software based)
   - Highly scalable real-time graphing system
   - Specifically designed to handle numeric time-series data
   - Good at graphing numbers that change over time
ii. Smart TV to show the reading in bigger display at certain specific location on-site (hardware based)

RESULTS AND DISCUSSION

In this study, three methods have been identified and being implemented to ensure the radiation area monitoring system is always reliability and accessibility. These three methods are:

i. The Nuclear Facility Alert System (NAFAS)-based script to monitor devices availability
   - Written in Shell Script and configured to run in Linux environment with cron* (*: a command to an operating system or server for a job that is to be executed at a specified time) set to run twice a day (8.00 am and 2.00 pm) for every day in a week. For a time being, it is used only to monitor the sensors availability however it can simply be extended if needed in the future

ii. An Email system to send the alert for any device failure for intended personnel
   - Email sent by the server (where the script resides) to alert specified personnel for any monitored device failure. Easy to implement provided that the agency's email server open a relay and allow the server to send the email

iii. The Proper Standard Operating Procedure (SOP)
   - For troubleshooting the system failure (server, sensor and web interface)
   - When solid data (data received – background reading) over a threshold value limit

Overall, there are several issues that need special attention (Table 2). Some of the issues have already been tackled and others still need to be planned properly for easy expansion and implementation of the system in the future.

Table 2: Issues and actions

No.	Issues	Action taken / needed
1.	System maintenance and Compatibility - VB6 is not compatible and cannot be installed in Windows 2003 SP1 Server and above	Developed an open source based programming script that can act exactly with what it can do in a Microsoft-based environment
2.	Data size - The size of the data is increasing parallel with the increase in the number of monitoring devices and location	Procurement of new server with sufficient storage capacity
3.	Data reliability – collected data with noise / background reading	Introduce new Standard Operating Procedure (SOP) in the system to overcome the problem
4.	System reliability – database backup	Procurement and establishment of new backup server with sufficient storage capacity
5.	Processing power – number of sensors and data size will affect the searching function or process of generating the customized report	Procurement of new server with sufficient processing power
6.	Data Security – data access level	Single sign-on. Integration with existing system and Microsoft Active Directory

CONCLUSIONS

Earlier version of the radiation area monitoring system deployed in the agency was all the sensor (Ludlum) units are networked to a central PC-based station where data are logged and alarms posted. This method becomes a problem when the PC is not backed-up regularly and is not run on 24x7 bases. When the upgrade activity is done, we have connected the system to the real server which has a better performance; reliability and accessibility that can collect data 24x7 and backed-up regularly.

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