Automatic Meter Reading using LabVIEW

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Abstract

The Designing and implementing a system based on wireless communication. This paper presents an implementation methodology for a wireless automatic meter reading system using LabVIEW platform and ZigBee network technology. A system design using LabVIEW which is low cost, high performance, highest data rate, highest coverage area and most appropriate to deal with disadvantages of traditional meter reading such as errors in reading, inaccuracy, external conditions affecting readings, delayed work we have implemented meter reading system based on latest ZigBee technology. In this project we have designed and implemented wireless system network for measuring utilities reading such as electricity. The system is designed using electric meter, ModBUS protocol, National Instruments software and hardware, and ZigBee module in close communication with GPRS for distant communication. This system performs tasks such as taking meter reading, distribution of bills, sending notice, cutting and reconnection of flow automatically. This model can lead to great deal of costs saving in electricity metering.

Keywords: AMR, ZigBee, GPRS, NI, LabVIEW

I. INTRODUCTION

Over the traditional metering system and metering devices have gone through big changes in technology, improvement, and are expected to become even more sophisticated, offering more and more safety and services. Meters in the past, and today in a few countries, were electromechanical devices with poor accuracy and lack of configurability. Detection of Theft was also a big challenge. Such meters are limited to providing the amount of energy consumption on site only.

We needed an AMR system that could collect data from remote substation metering devices to provide real-time data for long-term data management as well as daily power usage. Also, we needed a system that could help utilities deliver a wide range of services.

Our application addresses the following key challenges with a traditional metering system:
- Dependency on a person for operation
- Large amount of time required for operation
- Human errors
- Limited access to metering device in rural substations
- Collection of data that is inaccurate and cannot be used for reliability analysis
- Inability to perform outage notifications

We developed a flexible substation AMR system with the help of National Instruments products family, ZigBee network protocol and a GPRS communication interface to collect data from the remote substation metering device. The NI Products provides a good solution for processing data, handling multiple tasks, and communicating with the TCP/IP networking protocol.

The AMR system is used to measure the electrical parameters from feeder metering devices installed at remote substations or consumer location. We built a system that provide two way communication between server and electricity meter over GPRS by sending electrical parameters and control signal to reach the goal of automatic meter reading. System can supply many capabilities such as efficient meter-reading, distribution, power monitoring and control, load management and time-of-use rate using designed AMR system.

GPRS has many advantages now a days such as more stable network with robust features, covers virtually all parts of the world, maintenance and security of data transmission. It satisfies the need of speed for data transmission required for automatic meter reading system.

II. SYSTEM ARCHITECTURE

We created a Wireless Monitoring Control System for utility companies to remotely communicate with energy meters and other devices without human intervention. Communication links such as GPRS/GSM are not viable for reading a large number of meters because either the consumer or the utility company pays the monthly charges for connectivity. The lower power ZigBee
communication protocol is based on the IEEE 802.15.4 standard and uses the free 2.4 GHz ISM band. This makes it viable to read a large number of nodes and justifies implementation and operation costs compared to its benefits. The C Series ZigBee module has a transmission range of 1.6 km in line of sight and 30 m in indoor urban areas, a data rate of 250 Kbit/s, low power consumption, small size, 128-bit encryption, and support for more than 64,000 nodes in a single network.

III. SYSTEM CONFIGURATION

We used the LabVIEW as a platform with a custom-made C Series ZigBee module (coordinator) as well as a TCP/IP stack GPRS modem, which act as a data concentrator for data collected from different ZigBee nodes (router/end device). With the Compact RIO field-programmable gate array (FPGA), we can integrate a third-party customized C Series module to meet specific industry requirements. ZigBee nodes act as the router/end device configured with the circuit breaker, transformer monitoring sensors, and the energy meter for data collection.

IV. SYSTEM DESCRIPTION

The Wireless Monitoring Control System has two main parts: one for the substation and the other for end consumers. The system reads the energy meter installed at the feeder/distribution transformer/consumer premises, and monitors the transformer oil level and temperature. The meter can interface with the ZigBee node (router/end device) either through optical probe or serial cable, depending on availability. At the substation, the system can control and monitor the switch-gear devices, such as the circuit breaker and isolator.
ZigBee nodes interface with the switch-gear device and transformer sensors use digital I/O and analog channels depending on the requirement, which eliminates the need for a control cable. Mesh network capability makes it possible to read the number of nodes using a single wireless network. It provides continuous connections, network discovery, and reconfiguration around broken paths.

Each module can act as a router, automatically routing data to the data concentrator through different paths, making networks reliable and ensuring data availability. The data collected by the data concentrator from different nodes is transmitted to the data center server via the Compact RIO GPRS modem, where it can be shared with different applications.

V. TEST SETUP

In order to test the functionalities, capabilities and consistence of wireless system a test set up is developed which includes following components

- 10 Metering point are taken and energy meter are installed with RF 2.4 Ghz and sub 865 Mhz modules
- Data concentrator unit having Coordinator unit
- Energy Meter (Modbus compliant)

The system will be with following configuration

Meter data reading consistence in various configuration
- Star Configuration
- Mesh Configuration

Meter reading for different distance to check the capability
- Line of sight
- With obstacle

A. Star Configuration using 2.4 Ghz frequency Module in line of Sight
## Test Results

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Data Reading</th>
<th>Distance from coordinator (Line to Sight) in meters approx.</th>
<th>Time Taken (Between Request Command and Data received)</th>
<th>Parameters (KWH)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>End Device</td>
<td>10</td>
<td>5.7 sec.</td>
<td>1.2</td>
<td>Consistency</td>
</tr>
<tr>
<td>T2</td>
<td>End Device</td>
<td>20</td>
<td>5.7 sec.</td>
<td>1.6</td>
<td>Consistency</td>
</tr>
<tr>
<td>T3</td>
<td>End Device</td>
<td>30</td>
<td>5.7 sec.</td>
<td>2.3</td>
<td>Consistency</td>
</tr>
<tr>
<td>T4</td>
<td>End Device</td>
<td>40</td>
<td>5.7 sec.</td>
<td>4.0</td>
<td>Consistency</td>
</tr>
<tr>
<td>T5</td>
<td>End Device</td>
<td>50</td>
<td>5.7 sec.</td>
<td>3.2</td>
<td>Consistency</td>
</tr>
<tr>
<td>T6</td>
<td>End Device</td>
<td>70</td>
<td>6.8 sec.</td>
<td>5.6</td>
<td>Consistency</td>
</tr>
<tr>
<td>T7</td>
<td>End Device</td>
<td>80</td>
<td>6.8 sec.</td>
<td>9.9</td>
<td>Consistency</td>
</tr>
<tr>
<td>T8</td>
<td>End Device</td>
<td>90</td>
<td>8 to 10 Sec</td>
<td>1.6</td>
<td>Not Consistency</td>
</tr>
<tr>
<td>T9</td>
<td>End Device</td>
<td>100</td>
<td>8 to 10 Sec</td>
<td>2.4</td>
<td>Not Consistency</td>
</tr>
<tr>
<td>T10</td>
<td>End Device</td>
<td>150</td>
<td>-</td>
<td>-</td>
<td>Not Readable</td>
</tr>
</tbody>
</table>

Fig. 4: Test Results

### B. Mesh Configuration using 2.4 GHz frequency Module in line of Sight

![Mesh Configuration using 2.4 GHz frequency Module in line of Sight](image)

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>Data Reading</th>
<th>Distance from coordinator (Line to Sight) in meters approx.</th>
<th>Time Taken (Between Request Command and Data received)</th>
<th>Parameters (KWH)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>End Device</td>
<td>10</td>
<td>5.7 sec.</td>
<td>1.3</td>
<td>Consistency</td>
</tr>
<tr>
<td>T2</td>
<td>End Device</td>
<td>20</td>
<td>5.7 sec.</td>
<td>1.7</td>
<td>Consistency</td>
</tr>
<tr>
<td>T3</td>
<td>End Device</td>
<td>30</td>
<td>5.7 sec.</td>
<td>2.4</td>
<td>Consistency</td>
</tr>
<tr>
<td>T4</td>
<td>End Device</td>
<td>40</td>
<td>5.7 sec.</td>
<td>4.1</td>
<td>Consistency</td>
</tr>
<tr>
<td>T5</td>
<td>End Device</td>
<td>50</td>
<td>5.7 sec.</td>
<td>3.4</td>
<td>Consistency</td>
</tr>
<tr>
<td>T6</td>
<td>End Device</td>
<td>70</td>
<td>6.8 sec.</td>
<td>5.7</td>
<td>Consistency</td>
</tr>
<tr>
<td>T7</td>
<td>End Device</td>
<td>80</td>
<td>6.8 sec.</td>
<td>10.0</td>
<td>Consistency</td>
</tr>
<tr>
<td>T8</td>
<td>Repeater</td>
<td>90</td>
<td>10 to 12 Sec</td>
<td>1.7</td>
<td>Consistency</td>
</tr>
<tr>
<td>T9</td>
<td>Repeater</td>
<td>150</td>
<td>15 to 20 Sec</td>
<td>2.5</td>
<td>Consistency</td>
</tr>
<tr>
<td>T10</td>
<td>Repeater</td>
<td>200</td>
<td>15 to 20 Sec</td>
<td>1.3</td>
<td>Consistency</td>
</tr>
</tbody>
</table>

Fig. 5: Test Results

### C. Star Configuration using 2.4 GHz frequency Module with obstacle

![Star Configuration using 2.4 GHz frequency Module with obstacle](image)
The automatic meter reading system using LabVIEW presented in this paper absorbed many advanced study results in embedded & computer technology and communication technology advantages. The meter-reading task can be finished at the management department of residence area by using this system. Meantime, the energy resources management departments can monitor the consumption of power in order to improve the utility of power. It's the basic to realize automatic deliver of energy resources.

The system has many significant excellences, such as wireless, low-workload, great quantity of data transmission high-veracity and low-expenses. The using of embedded system improves the stability of wireless data transmission. For a long distance transmission GPRS telecommunication has shown excellent performance at any conditions.
The AMR over wireless technology is ideal for many applications in the field of electrical distribution networks including load management systems, transformer monitoring systems, outage management systems, substation automation, smart metering and energy auditing.

REFERENCES

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