PLC Email and Paging System

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Abstract. This paper proposes a PLC driven email and paging notification system which can be integrated directly into an existing DH+ and Ethernet network at the Linamar CAMTAC facility. The purpose of the system is to reduce downtime when assembly line problems occur. Through simple ladder logic code, a message is sent from the DH+ network to Ethernet and arrives at middleware on a server. The server middleware intercepts messages and directs them to a WaveWare EMS server or email server depending on the message. The design was tested by simulation in the University of Guelph digital lab and partially tested at the Linamar CAMTAC facility. The design emphasizes reliability and implementation with no additional infrastructure costs.

Key words: PLC, Rockwell Automation, network, bridge, email, page

1 Introduction

CAMTAC Linamar - located in Guelph, Ontario - manufactures engine blocks on assembly lines that are controlled by PLCs. Currently, these PLCs are able to activate 3 status indicators to indicate normal, warning or error conditions. CAMTAC would like to add email and paging capability to every PLC on the plant floor. This is accomplished via a custom application which interfaces with the PLCs.

The stages involved in the design of the system were requirements gathering, research/information gathering, software development, testing and implementation. Much of the process involved discovery of existing systems and re-evaluation of constraints while developing the final design.

2 Existing Infrastructure

The network of PLCs communicates using a Data Highway+ (DH+) network which allows peer-to-peer communication. Each PLC is addressed by an octal node number. RSLinx is a program developed by Rockwell Automation to facilitate communications between PLCs and PCs. One of the functions of RSLinx is to maintain a virtual node which allows a DH+ equipped PLC to send messages addressed to the RSLinx application. However, a ControlLogix (CL) gateway device is required to bridge the DH+ network to the Ethernet where the PC resides. RSLinx provides a Dynamic Data Exchange (DDE) interface to allow other Windows applications to receive data from RSLinx.

3 Requirements

The final system is subject to the following two constraints:

- Ladder logic must not adversely impact the PLC operation.
- Network traffic must not adversely impact DH+ or Ethernet performance.

The system is also designed to maximize: reliability, maintainability, ease of implementation and extensibility.

4 Architecture

Fig. 1. An overview of the complete system with arrows indicating direction of information flow.

A PLC begins by sending a message which contains a request to send an email or page. The message is routed over a ControlLogix gateway which bridges the DH+ network to the plant”s Ethernet. Once on the Ethernet, the message is routed to a PC which is running RSLinx. The message is sent using a propriety protocol that is understood only by Allen-Bradley products. RSLinx is able to communicate using Allen-Bradley protocols and so it can be used as an intermediate to extract the message content. The message content is then pushed to PLCMessenger, which parses the content and acts upon the original request by the PLC.
5 Implementation

5.1 PLC Ladder

The PLC only requires an additional MSG block to be inserted into the ladder program. A string file is required to define the message that will be sent.

5.2 Message Routing

Messages sent to RSLinx from a PLC are routed over a ControlLogix gateway. The gateway contains DHRIOM modules for communication with DH+ networks and an ENBT module for communication with Ethernet. A message sent by a PLC contains a header which defines a local bridge address, device address, link ID and a destination address. The local bridge address is the node number of the DHRIOM module of the CL gateway which bridges the DH+ network to the Ethernet. The device address is the slot number of the ENBT module in the CL gateway chassis. The link ID corresponds to the IP address of the PC running RSLinx in the routing table of the ENBT module. The destination is the virtual node address of RSLinx.

5.3 PLCMessenger

PLCMessenger is a custom application written in C# which sends emails and pages on behalf of PLCs. A connection to RSLinx is established using DDE (an Inter-Process Communication protocol for Microsoft Windows) which allows RSLinx to advise PLCMessenger when a new message has arrived. PLCMessenger parses the message to extract the message type, recipient and body. Email messages are sent using SMTP over a Microsoft Exchange server. Pager messages are sent using a proprietary protocol over a WaveWare EMS server. Should an error occur while sending an outgoing message, the message will be re-queued for transmission at a later time. If the message is undeliverable (i.e.: the recipient is not valid) the message will be logged and discarded.

User Interface

It is primarily a background process and provides an interface only for configuration and conveying status information. The application is not typically interactive with the user. When the application starts an icon is created in the system tray. Right-clicking the icon displays a context menu which can be used to exit or show the options dialog.

6 Testing

Testing the system occurred over the course of two days. A development PLC and laptop were connected to the plant network and communications between each component was tested. Network performance was also observed to determine the impact of the additional communications. Some components were tested using simulated inputs since the live factory systems could not always be configured while online.

7 Discussion

There are many solutions to networked designs. The key to successful implementation of a design is thorough requirements gathering. Several times, the design process was halted due to new information which invalidated existing design. A thorough interrogation of the client and even a site visit is highly recommended as part of any requirements gathering process.

The availability of information greatly influences the design of a solution. When low level protocols and specifications are known there is a much smaller dependancy on third-party components. However, it is often the case that many components are proprietary. This will increase the cost of the design as third-party materials are required to interface proprietary components.

8 Conclusion

The system that has been designed meets or exceeds all the constraints and criteria. Implementation requires only miniscule changes to the PLCs and ControlLogix gateway. CAMTAC already owns the licence for RSLinx so there is no additional cost. Communication between components relies on established hardware and software by Rockwell Automation. The final design meets all constraints and optimizes many criteria to provide an excellent solution.

9 Acknowledgement

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References

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