

# Remote Ethernet PLC Networking and Control

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**Abstract** - Nowadays, in our highly automated, high-tech society, programmable logic controllers PLC are as common as our personal computers or laptops. They are more resilient and more compact than conventional computers, they can be programmed to be very specific tasks and they can be used in all kind of environments. The paper presents one of the built-in technologies that stand behind the remote operation capability of PLCs, namely the Ethernet module. A low cost flexible platform is build around this module. Two case studies are provided: a remote monitoring and control system for passive greenhouses and a PLC matrix for industrial applications.

**Keywords** - Programmable logic controllers, Ethernet network, wireless communication platform, remote operation, passive greenhouse, PLC matrix.

## I. INTRODUCTION

The industrial controllers are more and more present in our life. Mankind will always be on the mission to conquer new territories. Sometimes those territories are unfriendly not only too humans, but also to the technological objects. In this case most of the state of the art personal computers, servers, will fail, due to the unfriendly conditions and frequent maintenance problems will jeopardize the projects. The solution is to find new ways, new computer architectures and new technologies to overcome these problems.

In this paper it is presented one kind of architecture, which can serve as a platform for many remote applications that need wireless networking. This platform encapsulates some industrial very task specific equipment, like the FX3U industrial programmable logic controller (PLC), and the FX3U-Enet Ethernet module [2, 3]. This PLC, as any other PLC, is a very resilient industrial computer, with no moving parts except some rough duty relays, consumes less power than a PC of any kind so it is perfect for unsupervised operation. The FX3U-Enet module is a dedicated Ethernet module for the FX3U PLC, allowing remote connection to the PLC, from any other location, via internet and satellite connection.

This paper has the following structure: section 2 provides an overview of the platform, section 3 describes the laboratory implementation and section 4 proposes two case studies. The conclusions are presented in section 5.

## II. THE STRUCTURE OF THE TEST SYSTEM

The used system structure was built from a FX3U programmable logic controller (PLC), FX3U-Enet Ethernet module, one router, one WIFI accesspoint and two laptops [1].

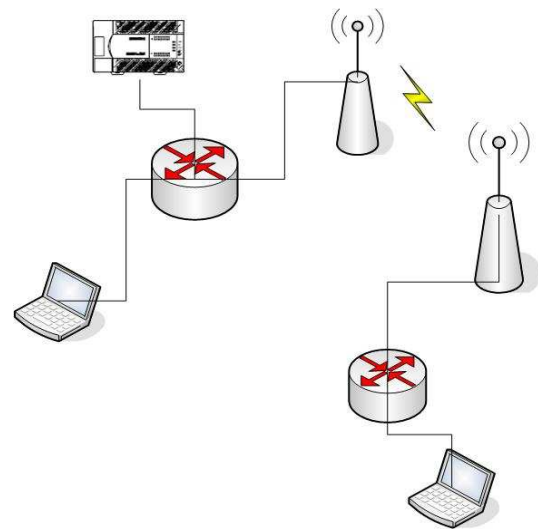


Figure1. Test architecture

This structure can perform a real-time, on-line, high speed communication with the PLC using a local LAN or WAN connection. In Fig1 the PLC is connected directly to the Ethernet network using the FX3U-Enet module. This module allows the PLC and the host computer to communicate via a TCP/IP or UDP/IP connections, using the MELSEC network connection, witch is a dedicated communication protocol for the Mitsubishi Melsec family. The hearth of this project is the Melsec FX3U-Enet ethernet module and the FX3U PLC. The FX3U PLC is equipped with 8 input ports and 8 output ports witch cand be transistor or relay based. The FX3U-Enet Ethernet module supports 8 simultaneous connections, using different protocols. The Ethernet module can handle different type of network architecture, like: star, bus, ring and mesh.

In Fig2 it is presented how the FX3U-Enet module uses different communication protocols, such as TCP and UDP transfer protocols related to the OSI model. Transmission Control Protocol (TCP) is a slower protocol, but it is a reliable transmission which uses sequence number to identify each byte of data. It has flow control and error detection. The UDP (User Datagram Protocol) is a much faster protocol but it lacks the flow control and the error detection, which are incorporated in the TCP protocol. This means that if an error has occurred, there is no knowledge of the error, and at the end of the transmission, the original data must be sent again.

The Ethernet modules support the TCP/IP and UDP/IP protocols.

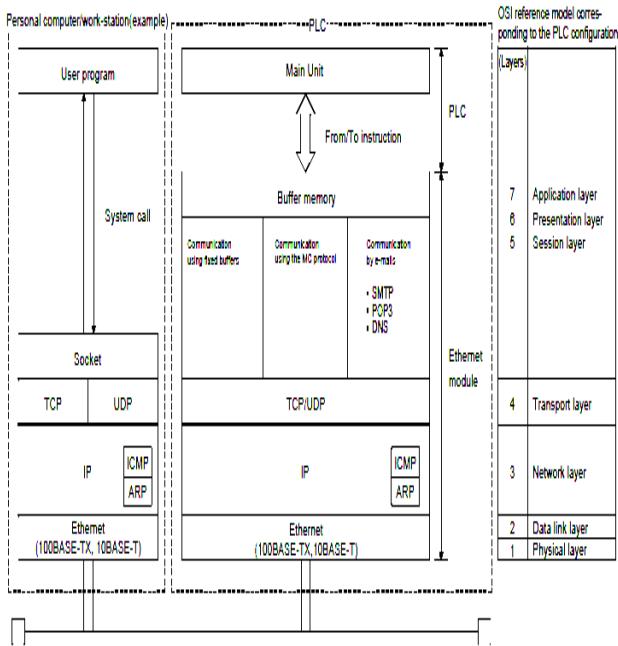


Figure 2. Communication Protocols for the FX3U-Enet

To establish a connection on the Physical layer (layer 1 on the OSI model) it was used o twisted pair utp cat.5 cable. On the wifi side the antenna was a rubber ducky antenna on the acces point side and an internal antenna of the laptop on the remote computer side. The software tools used in this project are:

- GX Developer (V 8.25B or later)
- FX Configurator-EN
- GT Designer 2
- Soft GOT1000

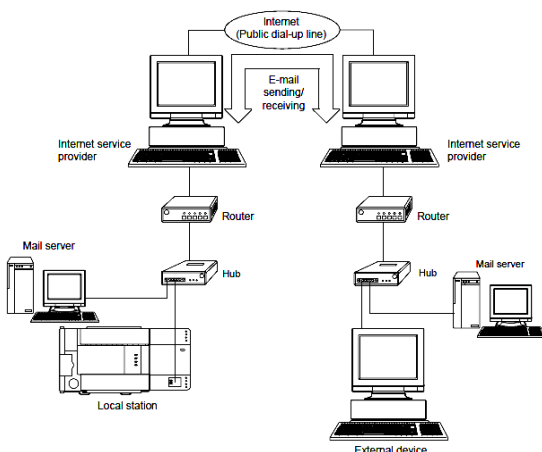


Figure 3. Set up for email sending/recieving

For even more flexibility we can set the Ethernet module to send email messages, using the local mail server as shown in fig3. The data can be sent as an 2K Word attachment or 256 words plain text.

The SoftGot 1000 program is a Melsec Got Display simulator. We used this program to test the remote monitoring and command functions, when we do not dispose of GX Developer.

### III. SETTING UP AND TESTING THE PLATFORM

The proposed platform was tested using the PLC mounted on a test bench, which was equipped with 5 input and 5 output relay ports, one timer, and one analog input/output port. On the same bench we mounted the FX3U-Enet module. To simulate the internet, we used a two closed circuit LANs, separated by a router. On one side of the router was the remote laptop and a wifi accespoint, and on the other side there was the PLC, the Ethernet module and the computer which initialized the PLC for the first time.

The Ethernet settings for the system were the following:

- The IP address of the router were: 192.168.2.1 and 192.168.1.1, and so we separated the 2 networks, simulating an internet connection.
- The IP address of the FX3U-Enet module was 192.168.2.4
- The IP address of the remote computer was 192.168.1.1

To make the necessary settings for the Ethernet module we use the FX Configurator-EN software lunched for the GX Developer. At this fase the PLC is connected to the PC with a programming cable. To make the settings the following steps needs to be completed:

- The operational settings are the main settings where we set the IP address of the PLC, the communication data code, initial timing to allow remote stop and run for the PLC, send frame settings, TCP Existence confirmation settings using Ping or Keep-Alive.
- At the initial settings we can add the response time of the module and we can introduce DNS addresses. If there are no need to change these values the default values are preset.
- At the open settings tab the communication protocols are set, these protocols can be set too TCP or UDP. For TCP communication we have Active, Un-Passive, FullPassive an Melsec connection. Melsec connection is an auto negotiating, auto sensing communication protocol between Melsec products. At the other communication methods the user needs to set the communication buffer type, the pairing options, host station port number, the targeted IP address, and the target device port number.
- Router relay parameters: here is told to the module the router IP address and the subnet mask pattern.
- E-mail settings consists of the password and email address, the SMTP server name or IP address, POP server name or IP address.

After confirming the settings the FX3U-Enet module restarts itself automatically.

To test the architecture, a program was created in GT Designer 2 for a remote LCD touchscreen panel. The panel was simulated in Soft GOT1000, a simulation program for the Mitsubishi GOT display family. To make the communication possible before the compilation some settings were to be made: the choice of the PLC, the IP address of the PLC, the port number, the communication type, the network number and the PLC number.

The actual testing took place in our laboratory, where we managed to communicate simultaneously with the GX Developer's monitoring program and the simulation running under Soft GOT1000.

The reprogramming of the PLC was done using the algorithm presented in Fig 4.

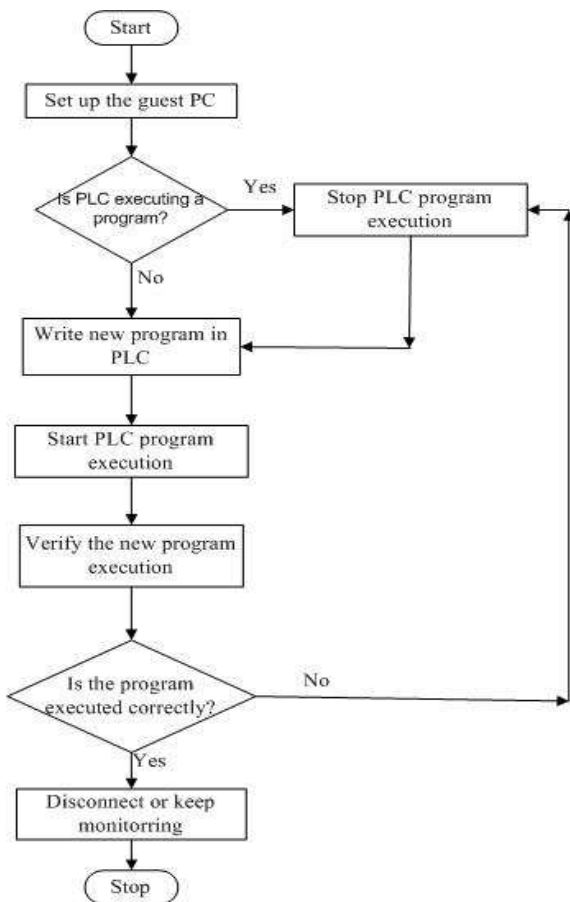


Figure 4. Flowchart for rewriting the PLC from a guest computer

As shown in Fig4., before we can send or read programs from the PLC, the GX Developer, on the guest computer, needs to be configured for Ethernet communication. When the communication is active, the currently running program in the PLC must be stopped so that the new version of the current program or a completely new program to be installed on the PLC. After the modifications are completed the execution of the program must be resumed. If after a verification cycle no errors are detected, the connection can be stopped in order for a new connection too be made from another guest equipment, if all the 8 connections are currently occupied.

#### IV. PROPOSED ARCHITECTURES

Based on the platform presented above in this paper there are proposed some architectures that use remote operation of the FX3U PLC and the FX3U-Ethernet module.

- a. Running and monitoring a passive greenhouse using satellite connection.

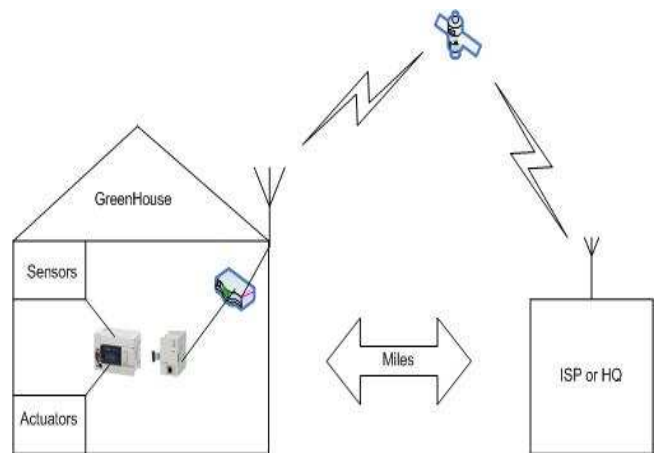


Figure 5. A remote passive greenhouse

In this architecture the Ethernet module enables the PLC and the users to communicate from large distances using satellite connections. The main components of the architecture are the 2 high gain directional antennas, which can be at either 2.4 GHz or 5 GHz, and the Ethernet module.

The Passive Greenhouses are using exclusively renewable energies: geothermal (cold water heat pumps), wind (wind turbines) and sun (photovoltaic panels) and they are independent of any conventional energetic infrastructures. Thanks to their energetic independence, if we provide them with a remote communication platform with global satellite coverage, in the future the passive greenhouses could be installed virtually anywhere [4].

- b. Building a PLC matrix for large scale industrial applications.

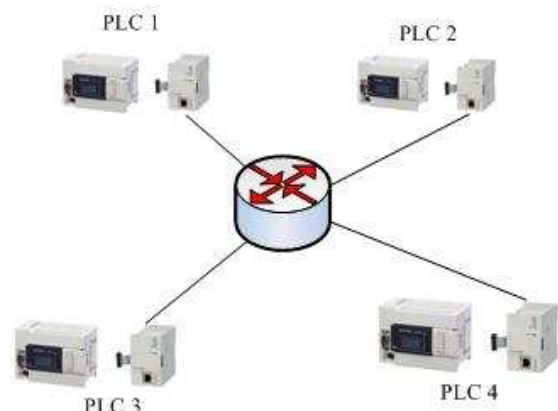


Figure 6. A PLC matrix

In the nowadays industry almost every machine or terminal is connected to a central server and processing unit. These connections are almost all the time made by PCs which act as media converters between the industrial unit and main server computers that command the involved systems.

With this module, several PLC's can be interconnected, and they can communicate with each other using the Ethernet network, or using a closed circuit Local Area Network.

Using this architecture, large scale industrial applications can be achieved, where the use of several programmable logic controllers is required.

## V. CONCLUSIONS

Nowadays the demand for remote operations and for sturdy, hardy systems is increasing. Having in mind that such devices, PLCs and their extension modules for instance, are much stable and use far less energy comparing to normal computers, they become ideal candidates for remote monitoring or control applications.

The paper presents a remote monitoring and control platform based on a widely used PLC and its communication module. The system is cheap, using few components, easy to develop and extremely flexible. Thanks to the today's satellite network coverage, the system is ready to support the development of an extended passive greenhouses network, as well as any usual remote control application. Combining the two proposed architectures the limit for a communication engineer which is working in this domain is only his own imagination.

## ACKNOWLEDGMENT

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