System Approach for Design and Construction of PLC Training Laboratory

Daniel Wong, Harold Peddle
College of the North Atlantic

Abstract

Programmable Logic Controller (PLC) technology is undergoing rapid technological changes as a result of the advances in control and instrumentation technology, and the associated fields of computing and communications. This paper describes the approach used for planning, design and construction of a PLC training laboratory by College of the North Atlantic. This paper highlights the importance of adaptability, safety, reliability and maintainability of the system. It also discusses the capability of the lab to be accessed from remote sites through wide area networks (WANs) connections on an open architecture non-proprietary system.

I. Introduction

The new PLC training laboratory consists of PLCs, PC computers, Human Machine Interface (HMI), variable speed drives, local panels, actuator/sensor modules and distinct, yet interconnected networking capability. In today's environment, it is important to have remote access ability through Ethernet/Internet in order to provide training at remote areas. This capability will also allow users access to the laboratory from remote training sites. Further, the installed system must be flexible to facilitate additions and modifications in the system.

II. Discussion

This paper discusses how these issues have been addressed efficiently in a laboratory at College of the North Atlantic. In order to address the networking capability among remote PCs, local PCs, and local PLCs, the HMI and field devices, the networking can be classified at three levels. See figure 1.

The first level is the Ethernet (LAN and WAN) which enables communication between PC and PLCs. This Ethernet system must meet a common standard which in this application is IEEE 802.3. This allows many multiple manufacturers of Ethernet compatible devices to access the network at any given time.

The second level is the Fieldbus system which enables communication between the PCs, PLCs HMI and the drives. It is a multi point interfacing system which enables communication between PLCs and field devices. Multiple masters and slaves can co-exist on the same network.

The third level is an actuator sensor interface network commonly referred to as ASI. See figure 2. This is a bit level structure with single master to multiple slave actuators and sensors on one specific cable. These are performed by means of two wires instead of multiple individually wired devices. Communications and power are supplied by single, two wire cable. This cuts down the commissioning time and installation costs.

With this system, actuators and sensors become communicative for which a direct Fieldbus has previously been technically not feasible or uneconomical. Previous interfacing often created a problem if vendors for the PLC, drive, HMI and field devices are incompatible. This means that once a system is applied from a specific company then it is not dependent on only that manufacturer.

In order to provide graphical representation of the monitored parameters of the process, Human Machine Interface (HMI) devices are installed which enable this capability and enable the Human Machine Interface controls. Both operator panels and touch screen technology are used.

The PLCs selected use Central Processor Units (CPU) with 32 bits architecture to provide high speed, accuracy and high resolution. Representation of variables, with real values, multiple arrays and structures, and other types of data are easily represented within the scope of the memory map of the CPUs.

The software base used for programming the CPUs is IEC 1131-3 which makes it compatible with other vendors and other base software structures.

In order to demonstrate variable frequency technology, master drives with full profibus capability were installed. The motor is installed in a separate enclosure since it can be started from remote areas. Also, since this process will generate heat in the enclosure, temperature sensors are installed for monitoring and control.

III. Vendor Product Support

On site assistance with 24 hour continuous, full-time telephone support is supplied by the vendor.

This is required to minimize downtime and maximize usage and enables the students to contact support should questions arise.

IV. Implementation

The physical and financial constraints of the project limited the installation to twelve workstations. Each station consists of a CPU with power supply, interface module for inputs/outputs port for networking of other PCs and CPUs, profibus port for connection to variable speed drive, ethernet card for communications, and actuator sensor interface communications processor (ASICP), an input/output module, a PC, a HMI, a drive, a local panel and an actuator/sensor module. The work stations were field built instead of pre-fabricated. This arrangement gave students the opportunity to do the actual installation while the laboratory was under construction. The field built arrangement with the PLCs surface mounted allows students to do actual connections to the input and output modules. This flexibility gives students more hands on opportunities.

V. Commissioning

Commissioning was performed by the students who installed the system under the supervision of the engineer from the vendor. From specifications, students confirmed all connections and operated the equipment to ensure equipment functioned in accordance to the specifications.

VI. Train the Trainer

On November 6, 2000, twelve faculty members attended a train the trainer session offered by the vendor on the workstations. Another session on drive technology was held in February 2001. A session on HMI and Networking is also planned.

VII. Conclusion

The installed non-vendor specific Fieldbus system enables the College to pick and choose among which devices the College wants connected to it from a wide variety of vendors world wide. This allows the College to save money and time. It also allows the College training laboratory to become adaptable to the ever changing hi-tech world by being fully adaptable to the new and ever-changing technology.

DANIEL WONG
Dr. Daniel Wong is the Chair of the School of Engineering Technology at College of the North Atlantic. He is a registered professional engineer in Canada, the United Kingdom and Hong Kong. He is also an honourary member of the Association of Engineering Technicians and Technologists of Newfoundland Incorporated and a fellow of the Institute of Chartered Secretaries and Administrators.

HAROLD PEDDLE
Harold Peddle is the Electrical Instructor and Coordinator of the automation lab at College of the North Atlantic. He is a graduate of the Fisheries and Marine Institute of Memorial University of Newfoundland. He is also a certified Journeyman Electrician and Industrial Instrumentation Technician.

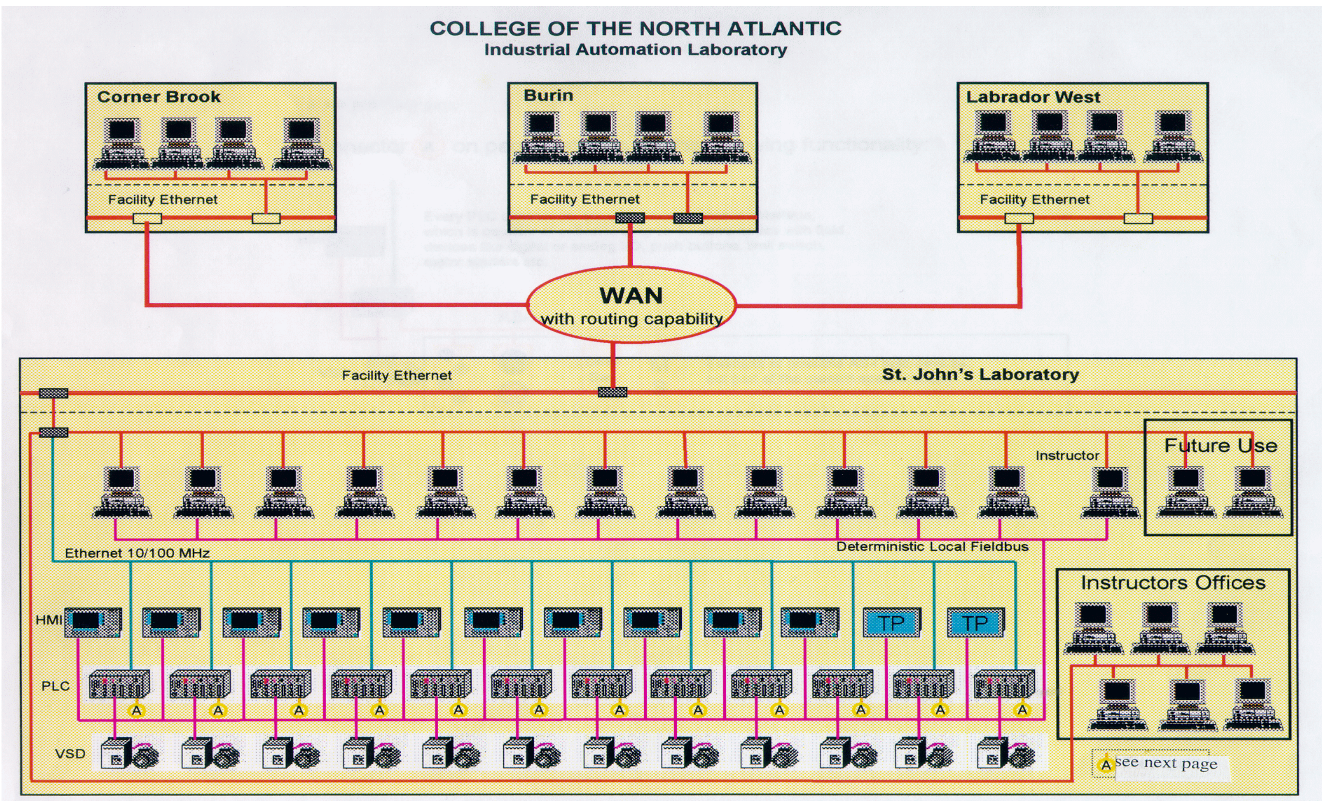
COLLEGE OF THE NORTH ATLANTIC
Industrial Automation Laboratory
Corner Brook
Facility Ethernet
Burin
Facility Ethernet
Labrador West
Facility Ethernet
WAN
with routing capability
Facility Ethernet
St. John's Laboratory
Instructor
Future Use
Ethernet 10/100 MHz
Deterministic Local Fieldbus
Instructors Offices
HMI
TP
TP
PLC
A
VSD
A see next page

Figure 1

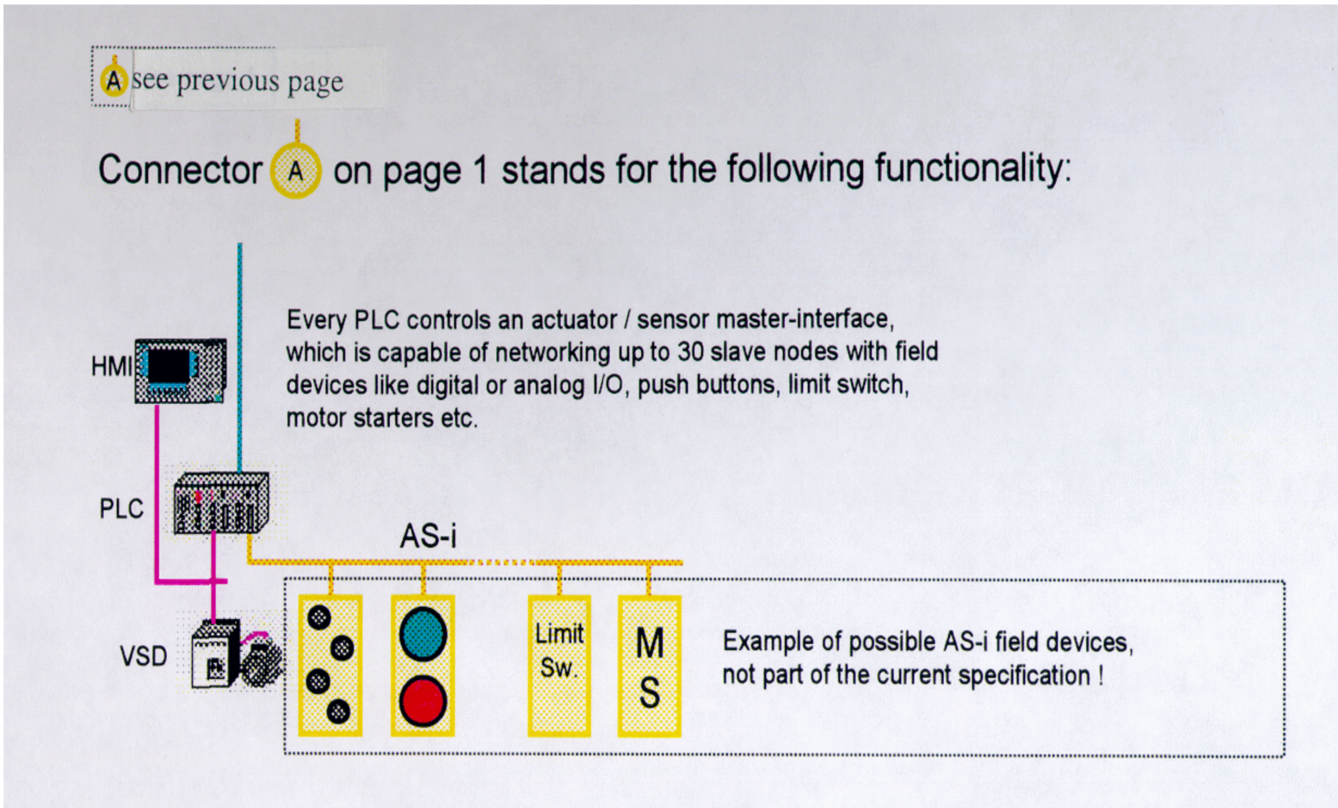
A see previous page
Connector A on page 1 stands for the following functionality:
Every PLC controls an actuator / sensor master-interface, which is capable of networking up to 30 slave nodes with field devices like digital or analog I/O, push buttons, limit switch, motor starters etc.
HMI
PLC
AS-i
VSD
Limit Sw.
M S
Example of possible AS-i field devices, not part of the current specification !

Figure 2