Ethernet TCP/IP communications control city water treatment plant

Water Utility:
City of Holland, MI

UNITED STATES

Systems Integrator:
Windemuller Electric
www.windemullerelectric.com

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Introduction

A water treatment control system relying on powerful Schneider Automation controllers programmed graphically using function blocks, an Ethernet control network rather than a proprietary control network, web pages stored within the controllers' Ethernet modules, and PC HMIs arrayed as independent network nodes has been assembled by the City of Holland, Michigan. The revolutionary automation replaced a PC card-based system from 1990 that was slow, required excessive re-booting, provided limited data, and could not accept the distributed intelligence desired for remote sites.

The project's web server application is believed to be a first. Plant personnel and the automation's systems integrator, Windemuller Electric, can quickly and remotely view — using the internet and a standard browser — statistics, controller configuration, 4X register values, controller personality, remote I/O status, configured drops, and configured DIO. In effect, the internet has become a private WAN . Authorized personnel can also view and edit control logic via dial-up software and the graphical programming tool.

Lower Cost Communications

To provide the most open control architecture for the 38.5 MGD water plant, a 10BaseT Ethernet network using TCP/IP protocol and Category 5 twisted-pair cabling was chosen as the communications backbone. The star topology, peer-to-peer network links five Schneider Modicon® TSX Quantum 486 PLCs and four

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Schneider Automation ethernet TCP/IP module and category 5 Ethernet cable.

Jim Van De Wege, Superintendent, Holland Water Treatment Plant, inspects Modicon CableFast pre-engineered cable-and-terminal block assemblies. The assemblies, which replace independently wired marshalling blocks and I/O connectors, reduced Windemuller Electric's cabinet fabrication and test labor by 200 manhours over five cabinets

Pentium HMI PCs with SCADA software through a 16-port Ethernet hub. The peer configuration permits the controllers to be edited from anywhere on the network or remotely via dial-in.

Total cost for the network's hub, Ethernet adapter cards for the PCs, an Ethernet router/PCMCIA modem for the dial-up connection, and necessary media converters was less than $3000. Should replacements be necessary, they can be bought at nearly any computer retailer.

The 10 Mbps Ethernet is more than fast enough for the application. Even considering the control system's 1002 I/O points (up from 105 points previously), the workstations are updated every 1 to 1.5 seconds. The network is 60% to 80% busy with message traffic, high activity for a TCP/IP network. Heavy traffic is due to two runtime HMI PCs polling the PLCs simultaneously. Fiber optic modems and cables connect two of the controllers to the Ethernet hub because cable distances are greater than 100 meters.

Logic Centered in Automation Controllers

The five controllers provide the lion's share of the automation's intelligence. One controller each is dedicated to the following areas: Low Service Pump, High Service Pump, Odd Filters, Even Filters, and Settling Basin. The 10-filter water treatment plant is of conventional design, and the processes and flows have not been changed. However, control can now be fine-tuned and operators can make better decisions because of a substantial increase in information available on the HMIs, which can display any of 3000 tags. There are also many more alarms, enabling operators to detect and correct problems earlier.

No control is located in a PC, as it was in the past. All alarming and horn activations are performed in the PLCs for the highest reliability. Nearly all plant instrumentation was replaced with HART "smart" devices, allowing troubleshooting with a laptop from anywhere on the current loop. Variable frequency drives on low service pumps, high service pumps, and transfer pumps have boosted plant energy efficiency.

The systems integrator, Windemuller Electric, saved 200 man-hours of assembly and test labor in fabricating the controller cabinets using Modicon CableFast wiring. The pre-engineered cable-and-terminal block assemblies replace independently wired marshalling blocks and I/O connectors, and they eliminate point-to-point wiring checkout at this level. The cable is prewired at both ends and was purchased for the project fused and in lengths tailored to the cabinet layouts.

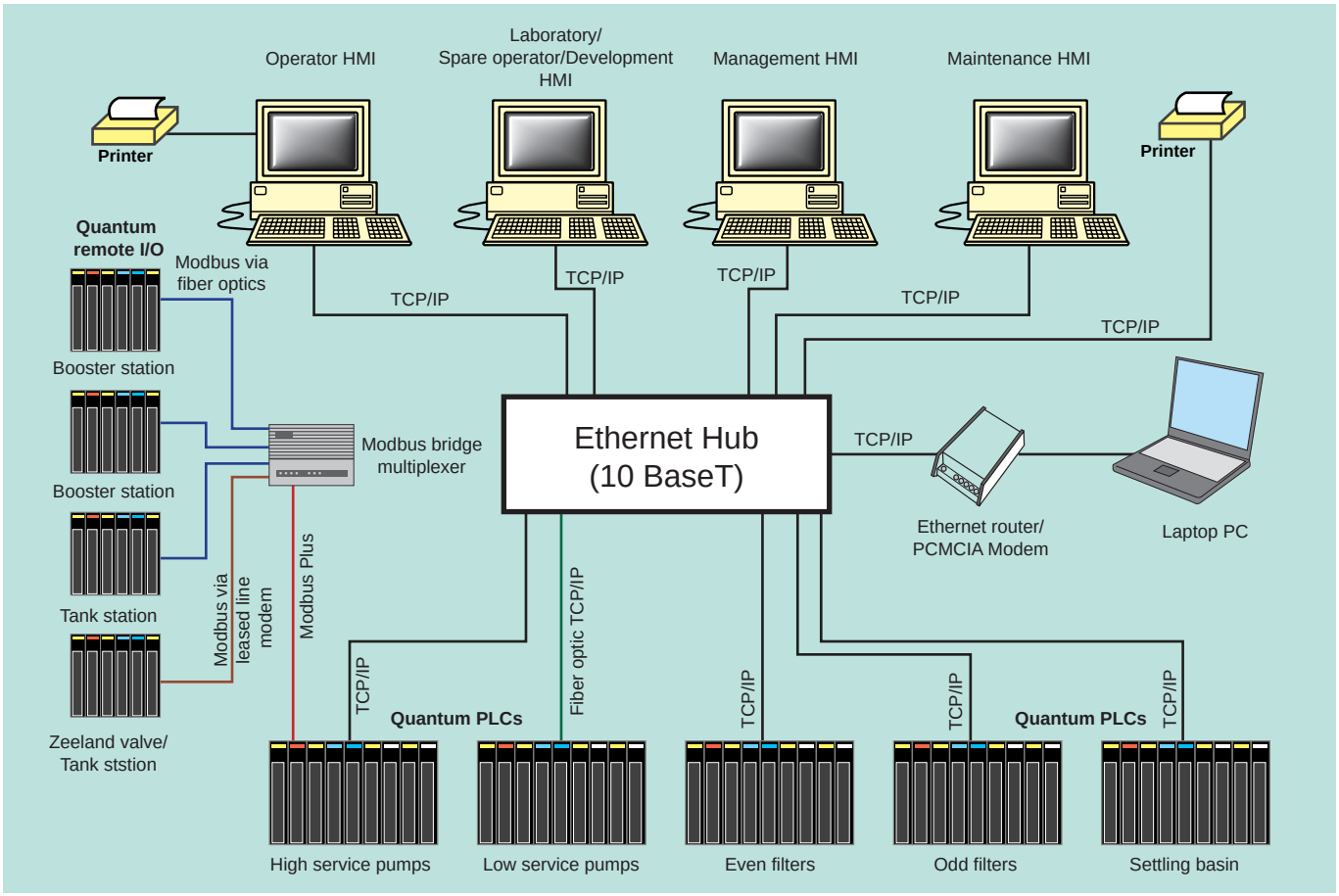
Remote RTUs Integrated

Control equipment at two remote Holland booster stations, a remote Holland tank site, and a Zeeland, Mich., valve/tank site have been upgraded to intelligent RTUs and integrated into the High Service Pump area's Quantum controller. Integration was accomplished through a Schneider Automation bridge/mux that bridges a 1.0 Mbps Modbus Plus® peer link from the Quantum controller with four 9.6 kbps Modbus® master/slave links to the RTUs. The Modbus links to the three Holland RTU sites use fiber optic modems; the link to the Zeeland RTU is by leased line/modem. Modbus is an open standard universally accepted by the utility industry for SCADA communications.

The level at the Holland tank site, and the operation of the two Holland booster pump sites that maintain that tank's level, are normally directly controlled by the High Service Pump area's controller. Should communications with any of the remote stations fail, the local RTU will assume control and follow predetermined instructions that vary by season.

Controllers Programmed Graphically

The five controllers were programmed by the systems integrator using Modicon Concept™ 2.1 software, a Windows-based graphical programming tool with five standard IEC 61131.3 languages plus Modicon 984 ladder logic and C. All programming was written in IEC Function Block Diagram, which was the simplest and most versatile language for the application and is the easiest for the water plant's maintenance personnel to follow and troubleshoot. Unlike ladder logic, FBD logic is concentrated in one diagram; there is no need to page through lists to find multiple uses for bits. Overall programming time was reduced at least 20% compared to writing ladder logic. Programming time for the plant's 10 identical filters alone was reduced approximately 80% through the development of a custom function block describing all operations of one filter. Once the algorithm had been written and tested using Concept's simulation routine, the block was copied for the other nine filters and the addresses modified to suit. Simulation, including PID loops, was accomplished in the programming PC without need



The top line control architecture for the Holland, MI water treatment facility.

Water treatment plant operator checks the SCADA Operator HMI's main screen. This terminal is one of four Pentium PCs that reside as independent nodes on the Ethernet network.

for an attached controller. It is expected that the custom block developed for the Holland plant will be reused with minor modifications by Windemuller Electric for other water plants.

Controller programs can be edited via the TCP/IP network or through a Modbus Plus port on each controller. A Holland Water Plant laptop PC with internal modem has been loaded with Concept programming and Symantec pcAnywhere dial-in software and fitted with Modbus Plus and Ethernet adapter cards. Only Modbus Plus alone can access the controller's kernel level, which was necessary during startup.

Workstations Are Independent Nodes

The water treatment plant's four Windows NT PCs serve as operator, management, laboratory, and maintenance HMIs. All are independent nodes of equal status on the Ethernet network. Databases and DDE drivers are separate, the SCADA packages are unlimited in tags, and the PCs are loaded with different suites of software. The only interaction between PCs are alarms, activated if one PC fails, that appear on the remaining three units.

The operator and laboratory stations are similar in that they both can operate the plant using a runtime version of the SCADA package. They are also loaded with the dial-in software. The laboratory station can be used for SCADA program development, and it contains Microsoft Excel software. The management and maintenance stations are identical, with read-only versions of the SCADA package their only application.

UPS units with surge protection and sized to supply 45 minutes of power are provided for every HMI, automation controller, RTU, and communications device. This precaution protects microprocessors and memory from power glitches, and it keeps the operator apprised of control statuses in operating and nonoperating areas of the plant and water distribution system.

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