Technical Information

DAQSTATION Networking
White Paper

TI 04L01A01-40E

Introduction

This document is prepared to summarize key issues in using DAQSTATION paperless recorders within a network. It is very important to know what a DAQSTATION recorder does when connected to a network in estimating loads for network traffic and servers. It is also important to see contents flowing through the network in keeping the network safe and secure. This white paper provides such information.

DAQSTATION is a family of paperless recorders developed by Yokogawa Electric Corporation for industrial and experimental applications, mainly for production management, recording and monitoring. DAQSTATION family shares a standard architecture built on a real time operating system with TCP/IP protocol suite ported from 4.3BSD implementation.

DAQSTATION family consists of several series of different applications. DX and MV series are equipped with recording functions for production management and experimental recording. DXP series has additional functions for operators to login to secure recording of the production. CX series has PID control function and provides human-machine interface to the control. These differences are in local display and operation, and they work on the same communication functions explained in this document.

Paperless Recorder and Networking

DAQSTATION is the second generation of paperless recorders, from historical point of view, providing the full benefits of networking functions. The first generation has just replaced recording chart with a LCD display. They freed people from supplying chart paper and ink that had absorbed people in managing paper recorders.

It is true that they injected another inconvenience to the business to compensate missing functions. Data was stored in an electronic medium in place of a chart paper. When one needed data for further manipulation and/or documentation, he/she had to remove the medium from the recorder and carry it to the office. Another situation stayed unchanged in managing recorded data. Data files were managed manually and had a risk of loosing them or storing them in a wrong place, which is completely same in managing a stack of chart papers.

DAQSTATION is introduced to address these inconveniences by utilizing networking capabilities as its standard feature. It not only resolves the problems but also allows users to enjoy more sophisticated capability in recording and monitoring to improve their business. Here is a short summary of such enhancements.

Automatic File Handling

Recorded data must be stored for years and be able to be retrieved when it is necessary. Chart recording had needed paper storage of controlled temperature and humidity to make charts survive long. Once data is stored on an electronic medium as a file, its capacity and lifetime became much larger, even boundless in a practical sense. One can manage and manipulate data much easier than before.

Though DAQSTATION has embedded data storage of disk or memory card, its capacity is not large enough to record data of months. They must be transferred onto much larger and less expensive media for long-term storage as a well-organized file system. File transfer function of DAQSTATION does this automatically over a network to secure data.

Remote Monitoring and Operation

DAQSTATION records data in a production or experimental site. One may want to read current values or recorded trend with a browser from the office. DAQSTATION is equipped with a Web server function to enable it and even to change operating parameters if needed. A recorded image on a browser can be embedded into a report or any other document electronically.

Email Notification

DAQSTATION is able to record data without human intervention. However, an instrument needs human service when it experiences a hardware problem. A chemical process needs an operator to take an action when its temperature becomes too high. One may want to be notified when such interaction becomes necessary. DAQSTATION has a capability to send an email to him/her in those cases. It comes to a PC in the office, pager or cellar phone.

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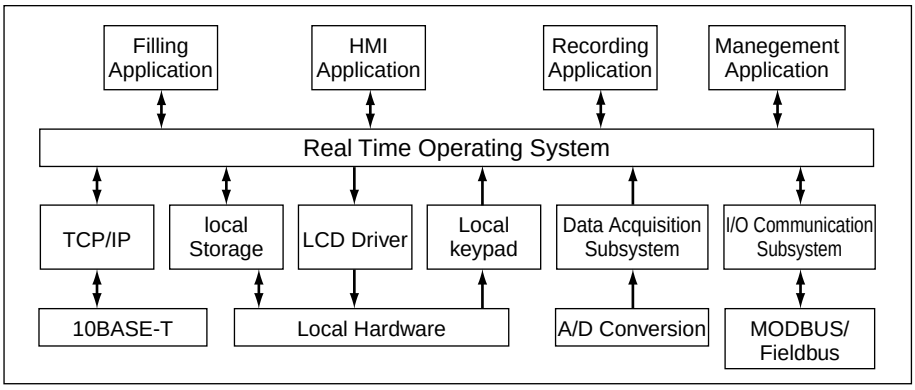
Application Architecture

Following figure shows the technical architecture of DAQSTATION recorder family. An industrial microprocessor runs applications on a real-time operating system. Applications are created when a DAQSTATION is manufactured. There is no mechanism to create another application or add an executable code at user's site, except offline upgrade provided from Yokogawa.



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Architecture of DAQSTATION family

Data acquisition subsystem converts analog signal from sensors (thermocouples and analog transmitters, for example) into digital data. Optional I/O (input/output) communication subsystem receives data from field devices such as PLC or pressure transmitter over MODBUS or Foundation Fieldbus. Data from subsystems are fed to recording application, which converts raw data into engineering unit to store and watch them. A Web server is embedded to show the recorded data, messages and configuration on a browser.

Management application provides information on device, diagnosis and communication. When configured, it sends an email to an SMTP server. Possible emails are periodic communication as a "heartbeat," hardware error detection, report generation, and abnormal value of measured data. DAQSTATION does not retrieve emails from any mail server.

Recording and Management applications accept telnet-like commands to get data or change configuration.

Local HMI (human-machine interface) application handles display and operation through LCD panel and keypad equipped on the front panel. Some series of DAQSTATION family have additional applications such as PID control and local login. These applications are local and do not communicate with the outside of DAQSTATION.

File handling application creates a file of recorded data or report on the measured data on the local medium. It has an ftp function; both client and server, to allow a host on the network have an access to the files on the medium.

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Protocols

Ethernet and TCP/IP

DAQSTATION has a 10BASE-T Ethernet port compliant to IEEE802.3 with DIX frames as a standard feature. Its MAC address starts with 00.00.64. MAC address is visible on the LCD screen if you press FUNC key on the front panel and select Log and then System soft keys.

If you select Commu soft key instead of System above, the screen shows communication log. At the right-top corner of this display, Ethernet link status is shown. It illuminates in green when the DAQSTATION is connected to an active network and turns off (displayed in white) when the network is disconnected. The LED next to RJ45 connector on the back panel gives the same information except it flushes when DAQSTATION is transmitting an Ethernet frame.

DAQSTATION is equipped with IPv4 and has a fixed IP address because it has server functions. Subnet mask and default gateway are configurable. DAQSTATION is capable to find servers from configured host names if domain name server exists on the network and its IP address is given to DAQSTATION.

Protocols on IP are TCP, UDP and ICMP. Following ports are open as well-known ports of server functions. DAQSTATION can register up to seven users (administrator and six unprivileged operators) with individual passwords for secure operation.

TCP Servers of DAQSTATION

Port #	Max TCP User	Server	Application
21	2	ftp	Filing
80	1	Web	Recording
34260	3	Setting/Measurement	
34261	1	Maintenance/Test	Manage-
34264	(UDP)	Instrument Info	ment

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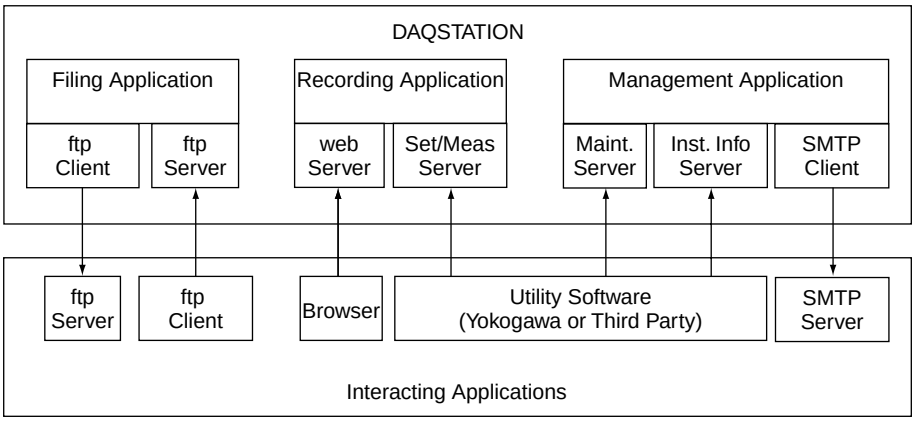
TCP clients are for ftp and SMTP. Their port numbers are larger than 1024 and chosen by applications.

Following figure shows clients and servers in DAQSTATION. Application protocols are explained.



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DAQSTATION Clients and Servers

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ftp

Filing application creates files of measured data when the size of data on the memory cache reaches the threshold or by other conditions. A report file (daily, weekly, etc.) is created when DAQSTATION is configured to do so. They are stored in a local medium (disk or memory card), to which DAQSTATION allows an access through ftp server. DAQSTATION ftp client automatically transfers them when configured to do so.

DAQSTATION ftp server shows the root directory of the local storage medium when a client logs in. Measured data and reports are stored in a configured directory (default is Ädata0). A user is able to get, put or delete files.

If ftp client is activated, it tries to transfer files to external server(s) when they are created or at any appropriate time. DAQSTATION keeps information on two ftp servers, primary and secondary. It accepts ftp server identification (either host name or IP address), login name, password and initial path as configuration for each server. It tries to transfer files to the primary server first. It then tries to transfer files to the secondary server only when it fails to transfer files to the primary server.

WWW-http

DAQSTATION recording application provides its Web page to show the display and messages, or allow remote operation (only for privileged users). Expected browser is Microsoft Internet Explorer 4.0 or later.

SMTP

Mail client of management application can be configured to issue an SMTP MAIL command when it needs to send an email on the configured event. DAQSTATION accepts configuration on SMTP server by IP address or host name, two groups of recipients (in 150 characters for each) and sender's name.

Causes of emails are (1) periodic, (2) hardware problem, (3) report generation, and (4) abnormal measured value. For each cause, DAQSTATION is configurable of triggering event, recipient (one from two groups), subject and the message text of two lines (up to 64 characters for each). DAQSTATION web page address and current measured values can be added to the email. Following table shows the contents of emails, where contents in '<' and '>' are configurable while contents in '(' and ')' are created for each email. DAQSTATION does not create any email content by itself except timestamp and optional measured values.

Email Content from a DAQSTATION

Item	Content
Subject:	<Configurable subject of the mail>
From:	<Configurable address of sender and return>
To:	<Configurable recipient address>
Date:	(Time added by SMTP server)
Body:	<Optional configurable Web address>
	<Configurable text line #1 of 64 characters>
	<Configurable text line #2 of 64 characters>
	< Text on email cause, "Report" for example>
	<IP address of DAQSTATION>
	(DAQSTATION local time and date)
	(Optional measured value)

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Utility Protocol

DAQSTATION recording and management applications have three servers of proprietary command/response protocol for measurement, their configuration, diagnosis and device information. A command is a text string accompanied with parameters. Several commands launches binary data transfer. Hewlett-Packard developed the fundamental idea of this protocol in controlling their instruments over HP-IB or IEEE488 bus. Commands and responses are fully specified in DAQSTATION instruction manual.

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Network Load Consideration

It is reported that some devices broadcast many frames to overflow the network. DAQSTATION does not broadcast frames except ARP requests, which is necessary before DAQSTATION initiates TCP connection. Therefore major source of network traffic load by DAQSTATION is the transfer of measured data via ftp or utility protocol. This section provides method to estimate this load.

An analog measured value is stored as a four- byte data for each sample. An output value of computation function of recording application needs eight bytes to store. Data amount created in a second can be estimated by multiplying above data size with sampling rate. It is 10-20% larger in size for time stamping and management information.

This value gives a good estimate of network traffic because other files are relatively small and email transfer is very rare. If ftp communication is expected to overload the network, say 30% or more, DAQSTATION recorders and ftp server should be installed in a dedicated collision domain, which is separated from main network by a switch.

The same consideration is applicable for a data logging utility collecting data from DAQSTATION with proprietary protocol, because network traffic load is same if measured data is transferred in binary format over the network. Though it is very rare, the load should be doubled if both ftp and utility transfer data over the network at the same time.

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Security Consideration

This section discusses the security risk in using DAQSTATION on a network. The best approach is to be pessimistic and sensitive to any potential security violation by an evil heart rather than to be too optimistic or innocent. As shown below, human factor and tapping are of more concern than DAQSTATION itself.

Risk of Virus Infection

DAQSTATION is free from the concern of virus infection. It does not have POP/IMAP email retrieval protocol, through which most of recent viruses spread. It does not have any mechanism to run an executable file even if somebody put one on the medium. It does not contain target applications of viruses or macros such as Microsoft Office, Outlook, or browsers.

Risk of Invasion

DAQSTATION has five servers; Web server, ftp server and proprietary command servers. They are not capable to launch any other client by themselves, which prevents anybody login to anther system from DAQSTATION, or send an email of unknown content. DAQSTATION is totally useless for hackers.

Important data in DAQSTATION is protected by password authentication. They are safe as far as the password is kept confidential. An ftp login from a PC has a risk of user name/password leakage by tapping because they are transferred in a plain text. Of course, there is always a chance of human careless leak of password. When DAQSTATION was invaded through tapped line, for example via telephone line, projected damage of subversive activities is leakage of recorded data and destruction of recorder configuration.

Risk of Information Leakage or Destruction

Since DAQSTATION stores a very limited amount of network information, e.g., IP addressing scheme, default gateway, and servers, the potential damage of their leakage from DAQSTATION is smaller than that from a PC. An important one might be information on external ftp server (server address, user ID and password) to login there. The risk of leakage is low because this information is not visible from any DAQSTATION server but it could be tapped when DAQSTATION ftp client transfers it on the wire in a plain text.

Recorded data is visible through servers, which could expose process data to unknown person if he/she is able to login. Through ftp server, he/she can delete or replace existing data files. Administrator password for DAQSTATION must be securely kept confidential to avoid this.

Even when DAQSTATION and PCs are on a secured network, an email goes out beyond the firewall if the recipient account is outside. This is a case when an operator forwards emails to his/her cellar phone or pager. Since SMTP is text-based protocol, there is a chance somebody intercepts the message. Message text must be configured very carefully to avoid unnecessary information leakage.

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Networking Aides

Most of DAQSTATION users are neither network expert nor system administrator. It is the best way for them to install DAQSTATION into an existing intranet by working with company's network/ system administrators. Even when this is possible, it is preferable for them to have some knowledge and experience of DAQSTATION and networking. If this is not possible, they need to build a DAQSTATION network by themselves.

Yokogawa offers a small tutorial document, "DAQSTATION online in three days," for them to have an experience of using DAQSTATION over a bench-top small network and some knowledge of network technologies.

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