Data Acquisition

Introduction

Purpose

This document is intended to familiarize the new user with the operation of the NAQS data acquisition system. It provides an overview of the NAQS Server package and guides the user through the initial startup and configuration.

References

Please refer to the following sources of additional information as appropriate:

1. The Software Reference Manual provides a thorough discussion of each Nanometrics program describing all options, input parameters, etc.
2. The Windows NT Primer section of this user guide provides a brief introduction to using the Windows NT operating system.

Description

Overview

The data acquisition system software includes the NAQS Server software and the NAQS Client software package. The NAQS Server package performs all the acquisition tasks including the data recording, trigger detection (seismic data only) and IP data distribution to NAQS Clients. The NAQS Client package includes programs which read the TCP data streams generated by the NAQS Server. Programs of the NAQS Client package are intended to be used on remote computers connected via local intranet or Internet to the NAQS acquisition system. The Nanometrics NAQS Client programs provide the user with on-line graphical state-of-health and near-real-time data monitoring. The Software Reference Manual includes a detailed description of the NAQS Server data streams and a sample C code for a data stream client program. Using this information, system operators can develop custom data stream readers.

In order for NAQS Server and NAQS Client to deliver their full functionality other additional software packages need to be installed. These are: Dynamic Link Libraries, Watchdog, General Utilities and Data Playback.

NAQS Server

The NAQS data acquisition software is considered to be the main engine of the entire acquisition system, performing all of the acquisition, trigger detection (seismic only) and data storage tasks.

The primary role of NAQS Server is to collate and store incoming data in ringbuffer files. NAQS Server receives either seismic data digitised by the Nanometrics 24 bit digitiser (HRD) or serial data. The data is ported to the acquisition software in form of UDP packets transmitted by an RM-4 bridge multiplexer, Lynx satellite digitiser or Cygnus satellite serial data terminal.

The ringbuffer files are hard-disk based pre-allocated size files with circular data recording in which, when the ringbuffer is full, the oldest data packets are continuously overwritten by the newest ones. Using the ringbuffer technology, NAQS ensures that all incoming data is recorded and stored. From the ringbuffers, the seismic data can be extracted and post-processed by other programs or converted to the most common international data format. The serial data can later be extracted by an extraction utility program (SerialExtract) for post-processing. The data extraction process does not interrupt the data recording and ringbuffers can be accessed simultaneously by numerous users via the local area network.

The amount of seismic data stored in a given size ringbuffer can be estimated considering the channel sample rate used by the digitiser and the average background noise of the station. The incoming serial data is not compressed, therefore the capacity of the ringbuffers can be directly computed from the amount of serial data generated by the data source connected to the serial port

of the remote station (Cygnus). A tutorial included in this manual explains how to calculate the approximate length of seismic data stored in a certain size ringbuffer.

Seismic only: When data is received, NAQS performs a trigger and event detection and if the conditions configured in the trigger detection and event detection algorithm are met, NAQS writes the approximate start time and the duration of the event in an event list file. Using the extraction utility programs of the Data Playback Package, operators can extract all event data which triggered the system by simply running one single command. The trigger detection sub-system is based on the implementation of the STA/LTA trigger algorithm. Users can independently configure STA/LTA parameters (STA time window, LTA time window, STA/LTA ratio) for each network component. The STA and LTA values are calculated from filtered sections of the data. As with the STA/LTA parameters, scientists can configure the filter parameters (corner frequencies and filter orders) and the trigger detection module will only look in the configured specific bands.

In parallel with the data recording, NAQS is able to distribute various near-real-time information in form of TCP data streams. These data streams are referred to as private data streams and are acquired by the NAQS client programs running on computers connected to the NAQS Server either via a local area network or the Internet. Since computer network managers are implementing firewall protection for their networks, NAQS is designed to provide the data streams through most of the firewall configurations. A more detailed description of the various data streams is included in the Data Streams paragraph of this manual.

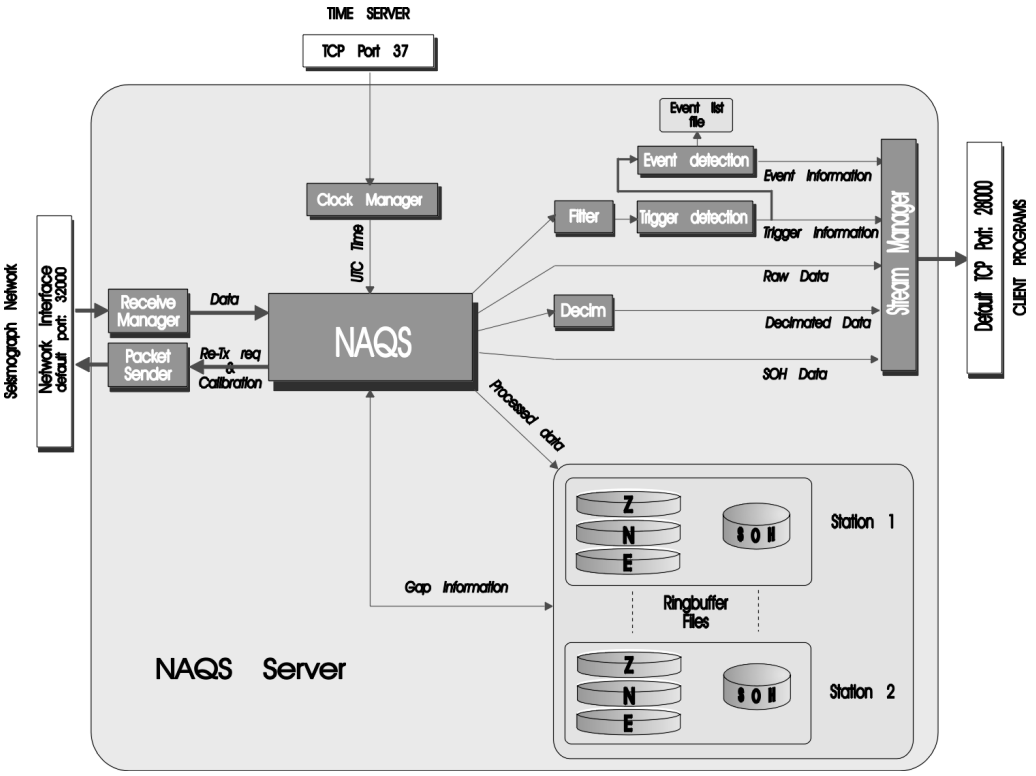

Figure 1: NAQS Data Flow Diagram

Configuration Files

NAQS requires the following two configuration files to be present in the current directory:

NAQS.ini	Defines basic operating characteristics for NAQS (IP ports, etc.)
NAQS.stn	Defines stations, channels, triggers and interconnections for this network.

Both files are simple text files and can be edited by any text editor.

Output Files Produced

The location and naming of the output files can be specified in the NAQS.ini and the NAQS.stn files. Detailed description of these files can be found in the NAQS man page (Software Reference Manual).

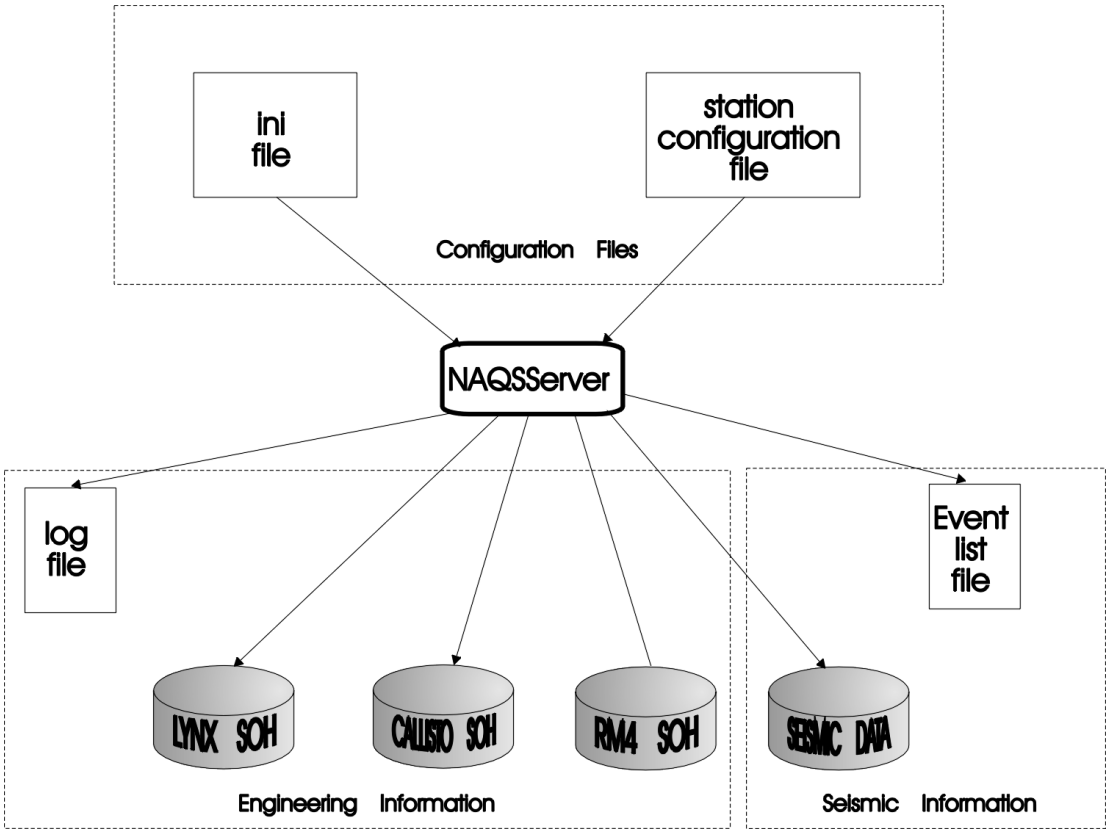

Figure 2: NAQS Files

Log File - NAQS.LOG

The log file contains a list of error and informational messages generated by the various modules of NAQS. It provides a summary of the system operation - particularly any unusual occurrences. The verbosity of the NAQS log file is user configurable in the NAQS.ini file. For normal operation we recommend setting the verbosity to Warning level. Whenever unusual operation is observed or more information is needed for other purposes, the Info verbosity level can be used for a limited time. We strongly recommend not using the Debug level because it provides very verbose information.

Event List File - NAQS.ELF (seismic only)

The event listing file contains a list of seismic events detected by the internal event detection routines within NAQS. It may also (optionally) list individual triggers generated by NAQS. This file can be used in conjunction with the ExtractP program to extract event-related data from the ringbuffers.

Ringbuffers

A ringbuffer is a circular buffer in which old data is overwritten as new data is received. Each ringbuffer stores data for a single data component in the original data-packet format. Ringbuffer filenames are automatically generated from the station and channel names specified in the configuration using the following formula:

filename = "R"
+ Station-Name (max. 5 characters)

+ "."
+ Channel-Name (max. 3 characters)

Data may be extracted from the ringbuffers into Nanometrics X-file format using the ExtractP program. Nanometrics supports several data conversion utilities to convert X-files to Y-files (suitable for analysis by DAN) or to various industry-standard formats such as SEED. Data may be extracted on-line (i.e. without shutting down NAQS), or viewed on-line using the on-line extract feature of DAN.

Each hardware component of the system (digitiser, satellite transceiver, bridge multiplexer) provides numerous State-of-Health outputs detailing battery voltage, internal temperature, GPS location, GPS state and timing accuracy, etc. as well as other external State-of-Health channels which are available for customer-specific measurements. State-of-Health (SOH) data for each digitizer is stored in ringbuffers in the original data-packet format. SOH ringbuffer filenames are automatically generated from the station name specified in the configuration using the following formula:

filename = "R"
+ Station-Name (max. 5 characters)
+ "."
+ SOH Channel-Name (3 characters)

SOH data may be extracted from the ringbuffers into comma-delimited text files (suitable for input to a spreadsheet program) using the SOHExtrP program. SOH data may be extracted into Y-file format (suitable for analysis by DAN) using the SOHToYP program. Data may be extracted on-line (i.e. without shutting down NAQS), or viewed on-line using the on-line extract feature of DAN.

Similarly to seismic and SOH information the data received on the transparent serial port (Cygnus) is recorded with the same ringbuffer technology. Serial data can be recovered using the SerialExtract program, which also extracts SOH information.

Private Data Streams

Connections to private data streams are established as a result of a direct ad-hoc request from the reader processes and can be for a finite length of time or indefinite length of time. Subscription requests of processes are sent directly to a specific TCP port of the NAQS Server computer. NAQS responds by sending the requested data directly to the requesting process. The access TCP port and security can be configured by the system administrators.

Private data streams are available as either a standard or custom data streams. Private data streams include:

- Short term complete compressed data (in sequence)
- Short term complete uncompressed data (in sequence)
- Trigger and event information
- State-of-health information
- Serial data

Programs of NAQS Client

Waveform (seismic) Waveform reads the raw data stream output by NAQS and displays seismic traces horizontally in a graphical window. It can display an unlimited number of traces in one window. All the traces are plotted using the same time scale but each trace can be individually scaled vertically. Waveform is a Java Program in JAR file format and as such should be started from the Java Runtime Environment (JRE). The JRE startup command parameters are included in the Waveform.bat file to which by default a shortcut is created on the desktop. All settings made in Waveform can be saved in a configuration file. Waveform does not need to have a configuration file

when it is started and it does not need to be restarted after every configuration change.

NAQS View NAQS View reads various data streams output by NAQS and provides a simple, intuitive interface to view near-real-time state-of-health (SOH) information, and to issue calibration and mass centering commands. NAQS View communicates with NAQS via TCP/IP socket, so it can be run either on the NAQS machine, or on any other machine which has an Internet connection to the NAQS machine. NAQS View is a Java Program in JAR file format and as such should be started from the Java Runtime Environment (JRE). The JRE startup command parameters are included in the NAQSView.bat file to which by default a shortcut is created on the desktop. All settings made in NAQS View can be saved in a configuration file. NAQS View does not need to have a configuration file when it is started and it does not need to be restarted after every configuration change.

Startup sequence

In default setup, NAQS Server is started (and restarted when necessary) by the Watchdog program. Watchdog software is a registered Windows NT service and therefore is started automatically on boot-up. Both programs being Java applications in JAR file format they should be started from the Java Runtime Environment. The JRE command parameters should be included in the WATCHDOG.INI file. NAQS Server can also be started manually from the NAQS.bat and respectively in the ExtractServer.bat batch files. However, only one instance of NAQS Server can run on a computer.

Programs of NAQS Client should be started manually. Refer to the Software Reference Manual for the description of the program launching options.

Directory Structure

Standard directory structure

By convention, all programs, libraries, configuration files and user data for the data acquisition system are kept in the **c:\nmx** directory. The organization of these directories is as follows:

c:\nmx\bin contains all the executable, batch and dynamic link library files related to the acquisition system. This directory is standard and cannot be changed by the user.

c:\nmx\user contains all configuration and startup files as well as log files generated by Watchdog and Extract Server. All Nanometrics programs (Watchdog, NAQS, etc.) should be started from this directory. This directory is standard and cannot be changed by the user.

c:\naqs32\user\data contains the log files generated by NAQS. This directory can be customized by the user from the NAQS.stn file**.**

c:\naqs32\user\ringbuff contains the seismic data ringbuffers (one file per seismic component) and the State-of-Health ringbuffers (one file per digitizer). This directory can be customized by the user from the NAQS.stn file**.** Usually the ringbuffers for better disk-space usage, are created on a different partition than the system partition.

Running the NAQS Server Software

Introduction

This section describes how to get the system operating using the factory-default configuration. Later sections discuss how the system configuration can be customized, but that should not be done until after the factory configuration has been proven on the customer site.

Preparing the system for deployment

Before you start

Read the System Description and/or the Installation guide. Be sure you have an overall understanding of the system as well as being familiar with the features and the configuration of the system. If the installation has not been done by a Nanometrics engineer be sure that you followed the installation instructions before proceeding further.

Use a small network to get started

Seismic networks are often deployed over a wide geographic area. Nanometrics strongly recommends that you first set up a subset of your complete system in your central laboratory to become familiar with all parts of the system. For this purpose, connecting one digitizer is usually sufficient. It is not necessary to connect a sensor for this exercise.

For systems making use of TCP/IP via dial-up, Local Area Network or Internet communications, side-by-side operation of the different computers is recommended. It is essential that the operator become familiar with the use of NAQS as a local user in order to understand the differences between local and remote operation.

Disarm the watchdog

The system includes a hardware Watchdog Timer which resets the acquisition station hardware in the event that the acquisition software is halted. To avoid accidental reboots, it is advisable to turn the Watchdog Timer off during the early stages while you are becoming familiar with the system.

Locate the Watchdog Timer switch on the adapter I/O access panel of the acquisition system computer and note the two LEDs on this panel. Disarm the WD8 watchdog by turning the switch to the 'OFF' position. The 'ON' position of the toggle switch is towards the middle of the computer (towards the long side of the DB25 connector on the WD8). When disarmed, the green LED of the Watchdog Timer card will be off.

Automatically starting the system

The system has been fully tested at the factory and configured such that it will operate upon power up. Power up the system in the following order:

1. Power up remote site.
2. Power up printers (if applicable).
3. Power up the Acquisition computer system.
4. Power up the Data Processing computer system (if applicable).

The boot-up sequence for the NAQS server computer can take several minutes, depending on the way in which the system was shut down. During loading of the operating system, the watchdog service is started first. The watchdog service starts the watchdog program which then starts NAQS and Extract Server. All customized batch files can be started automatically by including them in the startup folder (refer to the Windows NT manual for more detailed information).

The initial objective of getting the system running is now complete. The next two sections will familiarize you with the NAQS display and lead you through a checkout to verify that everything is running correctly. It is important that you understand the basic operation of the system before attempting to change any of the system variables.

At startup, monitor the Watchdog program window for any programs which die immediately after being started. In such cases immediately exit the Watchdog program by typing ‘X’ in the watchdog program window and try to start the program manually. The cause of the crash can be found in the configuration files. Check the log file of the program and in most cases you will find the answer.

Note: ***Do not change any configuration options until you have verified that the system is running with the as-shipped configuration.***

Checking NAQS for normal operation

The NAQS display screen is a black command window showing in real-time the log messages. The log messages provide the first-hand messages about the system's operational status. These messages are also recorded in the NAQS log file, thus you can look for older messages not shown on the NAQS screen.

Check if data is being received

When you are using an RM4, first of all check the link between the digitiser and the RM4 bridge multiplexer. Log on to each RM4 on the network using the RM4 Application. Check if good packets are being received from all digitisers connected to the RM4. The number in the Good Packet field should increase after each SOH Request.

When using a Libra network check the satellite link status between the remote digitiser and the central hub. Log on to each remote VSAT transceiver with the Libra User Interface as well as to the central hub transceivers. Please, note that only the technical administrators of the Libra network can change configuration parameters of the VSAT transceivers.

Use the Waveform program to see a scrolling display of Waveform data for each channel. Use the 'Edit-Subscribe' menu to select which channels you want to see. Use the 'Edit-Set Screen Width' to set the width of the screen in seconds. Click on the trace name to set a scale factor for that trace. Once you have set up the traces and their scale factors, use 'File.Save' and WAVEFORM will remember the setup for the next time it is run. (See the 'Waveform' section of the 'Reference Manual' part for more information.)

Perform a summary extract of all ringbuffers. Check for gaps which are older than what the HRD internal ringbuffer memory can store. NAQS knows from the NAQS.stn file how much internal memory each digitiser has. Therefore, when started for the first time, in addition to recording the new data transmitted by the digitiser, it will request the data stored in the digitiser memory. Depending on the size of the memory and the station's average noise level, this data can be from 10 minutes to more then 8 hours. When receiving requested data together with new data a summary extract of the ringbuffers will show numerous gaps which can confuse the user. Therefore, it is advisable to perform the first summary extract after leaving the system to operate for a long enough time to acquire all requested data.

Run rbfsum on all ringbuffers to have hourly statistics of the first- and re-transmitted data packets. For the first few hours of operation the ringbuffer statistics will show that a high percentage of data was recorded after being re-transmitted. This is the data stored in the digitiser internal memory at the start time of the NAQS server computer. After the system has stabilized and communication links are good, the amount of the re-transmitted packets should fall to a few percent proving that the link is good.

Check the NAQS log file

The log messages provide a useful summary of the system operation - particularly any unusual occurrences. With verbosity set to Normal (as-shipped) look for the following messages in the start up sequence indicating that the system is probably operating correctly.

```
W 1998-10-01 10:31:23 ETH-A  NAQS.........(2) Software watchdog found.
W 1998-10-01 10:31:24 ETH-A  NAQS.........(3) Starting subsystems...
I 1998-10-01 10:31:24 ETH-A  StreamManager...(6) Data Manager started.
I 1998-10-01 10:31:24 ETH-A  StreamManager...(7) Soh Manager started.
I 1998-10-01 10:31:24 ETH-A  PacketReceiver..(1) starting receiver...
I 1998-10-01 10:31:24 ETH-A  PacketSender....(1) starting Tx thread...
I 1998-10-01 10:31:24 ETH-A  ArchiveManager..(5) opening all ringbuffers...
I 1998-10-01 10:31:24 ETH-A  DetectionManager(5) creating detectors...
I 1998-10-01 10:31:24 ETH-A  EventAssociator.(1) Event Associator started.
I 1998-10-01 10:31:24 ETH-A  SohMonitor......(5) starting...
I 1998-10-01 10:31:24 ETH-A  StreamManager...(8) Trigger Manager started.
W 1998-10-01 10:31:24 ETH-A  TimeClient......(1) adjusting clock 14140 seconds
```

```
I 1998-10-01 10:31:24 ETH-A  StreamManager...(9) Event Manager started.
I 1998-10-01 14:27:05 ETH-A  StreamManager...(9) Thread Monitor started.
I 1998-10-01 14:27:05 ETH-A  NAQS.........(4) Entering the main loop...
```

Checking network state-of-health

Engineering status information is reported in near-real-time by the NAQS software and is also recorded in the SOH ringbuffers. In addition to this you can monitor the state-of-health of the repeater and of the communication links.

There are three different ways to check the operational status of the system: reading the SOH data stream provided by NAQS, extracting SOH information from the ringbuffers, and logging in to the RM4 repeaters..

Online system SOH monitoring

Using the NAQS View program you can open various SOH views and monitor in near-real-time the status of each remote and repeater station. You are provided with important on-line information, such as HRD, RM4 or VSAT voltage and temperature, GPS status, mass position (provided that it is connected), etc. This information assists you in early problem detection and in preparation for quick troubleshooting.

Building SOH statistics

Using the SOHExtrP or the Extract programs you can extract various SOH information from each remote and repeater station from the ringbuffers. This information, by default, is recorded once every minute and therefore provides a sufficient amount of data for calculating precise statistics and plotting useful curves. This helps in maintenance planning and troubleshooting.

Extract regularly all SOH information for all stations, remote and repeater, and check these files in detail. The Playback manual includes a detailed description of the SOH files and the various pieces of information contained in these files.

Configuring NAQS For Your Network

Introduction

The complete configuration of the NAQS acquisition system is specified by the configuration files, **NAQS.ini**, often referred to as an initialization file, or ***inifile***, and **NAQS.stn**. often referred to as a station file.

Both files are ASCII text files which may be modified using any text editor. Each file consists of a number of ***sections***, each containing several ***parameters***. Sections are identified by a name enclosed in square brackets (e.g. [Network]). Each parameter is given on a separate line following the section identifier, in the format: ParameterName = Value. The configuration is changed by editing the appropriate fields. See the Reference Manual for a detailed description of all inifile and station file sections and parameters.

A factory configuration version of **NAQS.ini** and **NAQS.stn** are on the NAQS distribution disks. Reinstall this file, if necessary, to restore the factory configuration. Never modify the diskette copy.

Calculating ringbuffer sizes

The amount of data stored in a certain size of ringbuffer depends on the average signal level of the respective network component. The higher the signal level, the smaller the compression ratio, and therefore less data can be stored in the ringbuffer.

The ringbuffer size for each component should be calculated taking in consideration the total available disk space. The amount of data can be estimated taking into consideration how many samples are generated in one second, with how many bytes one sample can be represented (average: 1.3), the overhead (10%), and can be calculated with the following formula:

Days = Rbf / (Sr * 3600 * 24 * 1.3 * 1.1)

where:

- Rbf: the size of the ringbuffer in Mb
- Sr: sample rate
- 3600 is the number of seconds in an hour
- 24 is the number of hours in a day
- 1.3 is number of bytes used to represent a sample for a station with a typical background noise level.
- 1.1 is the packet overhead factor

Please note, that a higher the background noise of a seismic component the more bytes are needed to represent a sample up to a maximum of 3.

What can be configured?

NAQS configuration is provided by two configuration files. The first file, NAQS.ini, specifies general operating settings such as port numbers for TCP and UDP connections. The second file, NAQS.stn, provides information on the instruments, stations and channels that comprise the network. Both files are simple text files which can be created and modified using any text editor

The main purposes of the configuration files are:

1. to provide the name and location of each station connected to the network,
2. to define the name and characteristics of each instrument
3. to define the name and characteristics of each data channel
4. to specify which stations, instruments and channels belong together
5. to specify other settings such as file locations, file sizes and trigger-detection parameters.

The information contained in these configuration files are read when NAQS is started. You have to restart NAQS every time you make a configuration change in order for the changes to take effect.

Watchdog can be configured in its ini file WATCHDOG.INI including all controllable automatic processes, by default NAQS and Extract Server. As with the NAQS, Extract Server can be configured from its ini file EXTRACTSERVER.INI. The other non-automatic processes either do not need an ini file or configuration changes can be made using the GUI of the respective programs.

User-defined Default Settings

The full configuration for a large network may require several thousand parameters, thus increasing the size of the station file to an unmanageable size. However, recognizing that most networks consist of many (almost) identical branches, we simplify the station file by allowing the user to specify defaults for most repeated settings. It is only necessary to specify parameters for a specific instrument or channel when they differ from the user-defined defaults. This greatly reduces the size and complexity of the station file for a large network and ensures standardization of configuration over the network, while still providing the flexibility to configure each parameter individually if necessary.

How to change the configuration

Always back up your current version of **NAQS.ini** and **NAQS.stn** before making any changes so that you can quickly return to the previous version if you encounter any problems.

Caution: **Do not make any changes to the configuration before you are completely familiar with operation of the NAQS acquisition program. Read carefully and have the NAQS manual page (Software Reference Manual section in the Reference Manual) with you whenever you make a configuration change.**

Caution: **If parameters which are written into the header of the Y file are changed and NAQS is restarted with the new configuration, it will create new ringbuffers overwriting the existing ones. This can be**

avoided by changing the ringbuffer headers using the headedit prior to making the change in the naqs.stn file and restarting NAQS.

Caution: **If the size of a ringbuffer is changed in the naqs.stn file, NAQS will delete the old and create new ringbuffers. If the name of the ringbuffer is changed in the naqs.stn file NAQS will create the new ringbuffer without overwriting the old one. In this latter case care should be taken to allocate enough disk space for the new ringbuffers.**

To change the NAQS configuration, change the appropriate fields in the **NAQS.ini** and in the **NAQS.stn** file using any text editor and save your changes. The configuration file is only read when NAQS starts, so to make the new configuration effective, exit from NAQS using the **Quit** command. The software watchdog will restart **NAQS** and the new configuration will be in effect.