SEISNET

Seismic Network Automation Software

Version 2.3.1

By

Lars Ottemöller

British Geological Survey
Murchison House, West Mains Road,
EH93LA, Edinburgh, UK
E-mail: lot@bgs.ac.uk

and

Jens Havskov

Department of Earth Science, University of Bergen
Allégt.41, N-5007 Bergen, Norway
E-mail: jens@geo.uib.no

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1. Introduction

A common task in the operation of seismic networks is to combine various data acquisition and communication systems. The SEISNET seismic network automation software was developed to combine various types of seismic data sources into one virtual seismic network (Ottemöller and Havskov, 1999). SEISNET serves as link between seismic stations of different type and the SEISAN analysis software. The main operations carried out automatically by the SEISNET software are given in the following list:

- Retrieval of parametric information from seismic nodes
- Retrieval of waveform data from seismic nodes
- Network event detection
- Automatic phase identification, hypocenter location and magnitude determination
- Transfer of waveform data for a given hypocenter location and origin time

The work on SEISNET started in the beginning of 1997 due to the need for network automation software at the Norwegian National Seismic Network. SEISNET is mainly written in the script language Expect (Libes, 1995), which is available for most Unix systems. Expect is used to automate interactive programs like ftp and telnet. This means that SEISNET can make use of software without changing it. Some tasks will be done more easily in a different way than using Expect. In this version of SEISNET, parts of SEISAN (Havskov and Ottemöller, 1999) and Fortran programs are implemented. The Expect script, however, is the main part of SEISNET. Interpreted by Expect, this script runs like a program. It can be used interactively or non-interactively. If started interactively the user selects options from the menu, if started non-interactively certain functions are started automatically.

SEISNET is supported for the Sun Solaris operating system, it has also been partly tested on Linux. SEISNET can only be used in connection with the SEISAN, seismic analysis software, since SEISAN programs and the database structure are used by SEISNET.

Using SEISNET as seismic network automation software, the seismic network can be defined in a more general sense than it is done in the traditional way. To indicate the difference, it will be called a virtual seismic network (VSN) in this manual.

A seismic node and the virtual seismic network are defined as follows (Ottemöller and Havskov, 1999):

- A seismic node is any computer with communication ability, which gives access to seismic parametric and/or waveform data. Examples are a GSN station, a central recording unit in a seismic network, a seismic information source and any ftp database server.

- A virtual seismic network is defined as a system that links any combination of seismic nodes together into a network performing data collection and event detection.

This means that a VSN can simply be considered as a computer network, in which the nodes are selected according to the purpose of the network. It is assumed that the VSN central computer can communicate with all the nodes.

The seismic nodes that are presently supported are given in Table 1. Globally, there are hundreds of potential seismic nodes that can be used with SEISNET. Support for FTP servers in particular broadens the field of potential nodes.

Table 1. Seismic nodes that are presently supported.

Type of seismic node	TCP/IP	dial-up modem	parametric data	Waveform data, events	waveform data, continuous
AutoDRM	X				X
Finger quake (e.g. NEIS)	X		X		
FTP server	X		X	X	
Nanometrics NAQS	X		X	X	X
Quanterra	X	X	X	X	X
QNX SEISLOG	X	X	X	X	X
SEISAN database	X		X	X	X
SDAS	X		X	X	X
Windows SEISLOG	X		X	X	X
VME SEISLOG		X	X	X	X

(Continuous data can either be an extract from a continuous data stream, or transfer of continuous data that are segmented into files).

1.1 Information about SEISNET online

Homepage

Information about SEISNET can be found on the SEISNET homepage:

http://www.geo.uib.no/seismo/software/seisnet.html

Mailing list

As user you should subscribe to the *seisnet* mailing list. You will then receive all information on upgrades, problems and bugs through email.

To subscribe, send the following email message to *majordomo@geo.uib.no*

subscribe seisnet *(Note: This text has to be part of the body and not the subject!)*

You can obtain help from the mailing list server by sending the message

help

To *majordomo@geof.uib.no*

1.2 Latest Changes

Version 2.1.0, date 2001-12-05

- Support for Nanometrics NAQS
- Support for VME Seislog
- Automatically extract selected time windows
- Automatically extract data for location and origin time given by finger quake
- Separation of source code into a number of source files
- Finger quake support for ftp transfer
- Option to hang-up of modem after data transfer
- Compressed transfer of waveform files for QNX Seislog
- Moving of waveform files to SEISAN waveform database after transfer
- Use groups of nodes from the parameter file defined through TRANSFERSLOT
- Specify modem when starting SEISNET
- Support for ftp with QUAKE type

Version 2.3.0, date 2003-09-03

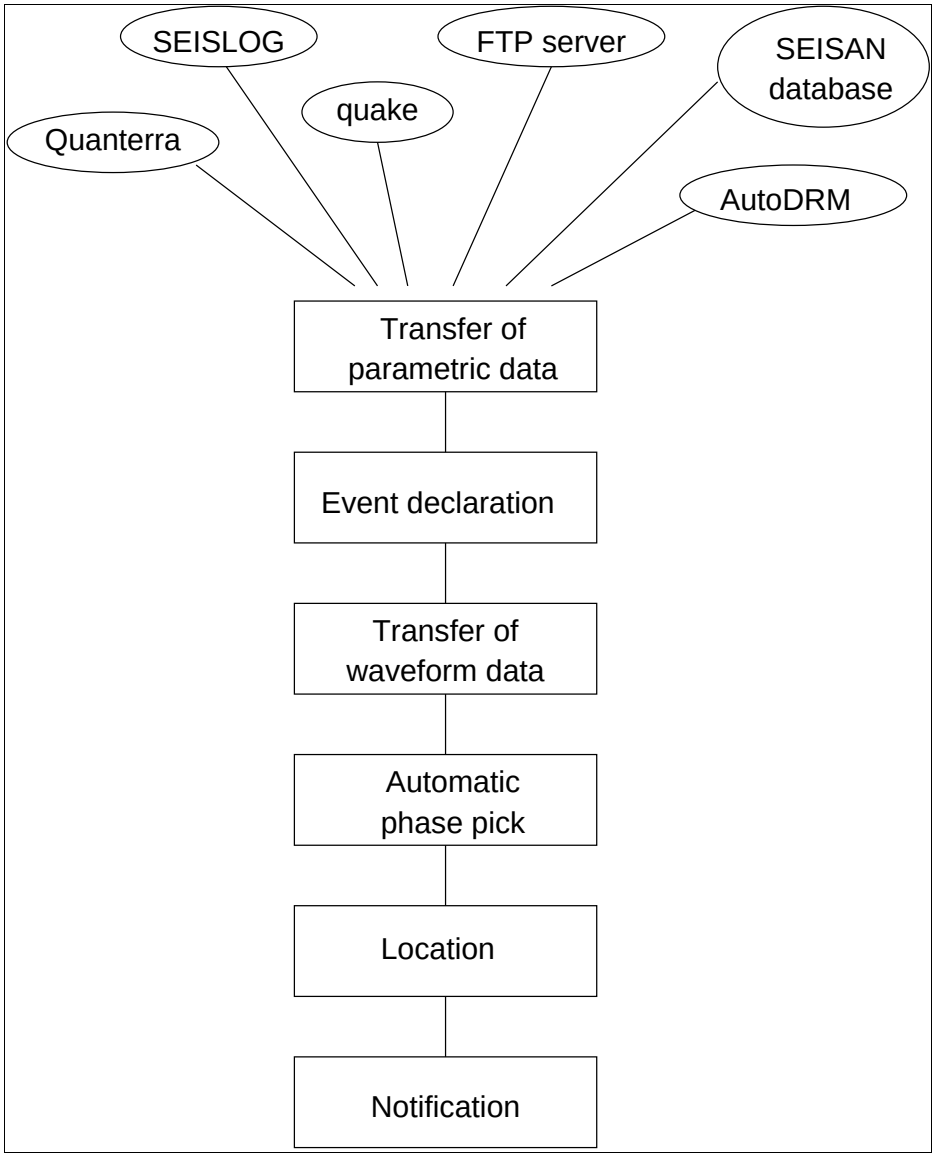
- New logfile system
- Event detection directory
- Waveform request directory
- Support for SDAS
- Support for SEISAN, both events and continuous data
- Nodes for network detection and waveform transfer only can now be combined in one parameter file
- Tool to list and kill SEISNET processes

This version of Seisnet is tested with Seisan Version 8.0.

2. How SEISNET works

The automatic SEISNET operation can be divided into four main tasks. These are transfer of parametric data, network event detection, transfer of waveform data and automatic processing (Figure 1). The tasks are independent and can be started automatically. Data transfer and processing can be done from present to several months back in time.

Figure 1. Concept of automatic data transfer and processing.



2.1 Directories

In order to understand how SEISNET works, it is essential to be aware of the directories that are used for temporary or permanent file storage. The most important directories are defined by the variables (setting done in parameter file):

- WORKDIRECTORY – this is where SEISNET works and data files are placed, except waveform files which optionally might be put into a SEISAN waveform data base.
- EVENTDETECTION_DIRECTORY – detection files are put here, and then processed by the network event detection, which combines files into the CENTRALDATABASE.
- LOGFILEDIR – all logfiles are put in here.
- WAVEFORMREQUEST_DIRECTORY – request files for waveform data are stored here, the request files are deleted after successful transfer.

2.2 Transfer of parametric data

During this phase, SEISNET transfers parametric data from the seismic nodes to the central computer, where the parametric data is stored in single databases for each node. The information from the seismic nodes is split into single event files. The type of parametric information depends on the seismic node. It might be trigger time, approximate P arrival time, start-time of the waveform file or hypocentral information. If a node is selected for network event detection, the event file is also copied to a directory, which contains detections from all nodes. In case a node is selected for waveform transfer, but not event detection, a request file in the waveform data request directory is created.

2.3 Network event detection

SEISNET reads parametric information from the single detection files in the event detection directory and the events in the central data base and sorts these with respect to time. A new event is detected if within a given time interval there are triggers on at least a given number of stations. The detections are then merged into one event, which is moved to a central database, while the single detections are deleted. In the central data base the request for waveform data is indicated in the event file (S-file, see SEISAN manual). For existing events in the central database, new triggers are added to the same S-file. At the same time, requests for waveform data are created as single files in the waveform data request directory. Using a minimum number of one trigger to detect events, triggers from all stations will be detected as events. In most cases, it is required that several stations have triggered within a given time interval.

Note: Currently the S-files, not used in detections, in the event detection directory are not automatically deleted. If too many become present, SEISNET stops. Either manually delete the older ones or set up a cron job to do so (see example later)

2.4 Transfer of waveform data

In this process, waveform data will be transferred from the seismic nodes. The requests are given by single request files that are created in the waveform data request directory. The system transfers the requested data and converts to SEISAN format immediately after transfer. After successful transfer, the waveform request files are deleted. The request files are locked (by creating a file with the suffix ‘.lock’) while data is transferred.

Note: If the central data base event files name is changed by the user, the request file will not know which S-file to update to indicate the transfer of data.

2.5 Master mode

The master mode gives the opportunity to use SEISNET for near real-time operation of seismic networks. The idea is to monitor one or a few master nodes e.g. every minute (or less frequent, defined in user's crontab file). In case of a detection on one of the master nodes, the data transfer for the remaining nodes is initiated. Depending on communication speed and the number of seismic nodes in the network, the data will be available in the data centre soon after it has been detected on one of the master stations.

2.6 Continuous data

With respect to data transfer in SEISNET, there is not much difference between triggered event and continuous data. Some acquisition systems like the QNX Seislog create ring-buffer files and the files can be treated like triggered files. Other systems like the Quanterra or AutoDRM provide continuous data without a reference to files and it is necessary to create a reference to continuous data segments within SEISNET. It is recommended (and supported by SEISNET) to store continuous data in a SEISAN continuous data base (see SEISAN manual). This means the waveform data files are kept in a station waveform database and the corresponding S-files are created in a parametric database.

2.7 Parallel transfer of data

Normally, SEISNET transfers data sequentially. However, for a large network or with slow connections, it can be an advantage to get data from several nodes at the same time. In this case, several transfer slots can be set up, where every slot represents a group of stations. If e.g. 3 transfer slots are set up, the network can be divided into 3 groups, each of which will start to transfer data sequentially at the same time. Ultimately, each node can be a assigned a different slot so all stations transfer at the same time. For more details see section 5.4

2.8 Extract waveform data based on PDE near real time locations

SEISNET can use hypocentral information from other sources, like PDE, to extract waveform data from selected stations. The system can be set up to look for events in a QUAKE type data base (like for PDE) and extract waveform data for a given set of nodes for these events. For more details, see section 5.5.3.

3. Installation and Setup

3.1 System Software

The SEISNET software is based on freely available system software, which has to be installed by the system administrator before SEISNET can be used. The required software can be obtained with SEISNET, however there might be later versions. The following table gives an overview of the required software and the places where the software can be downloaded.

Software name	FTP and WWW addresses
Tcl and Tk	www.scriptics.com; ftp.scriptics.com; ftp.cme.nist.gov; www.sunfreeware.com
Expect	ftp.cme.nist.gov; www.sunfreeware.com

Kermit	http://www.columbia.edu/kermit/
ncftp	http://www.ncftp.com

The easiest way to install Tcl, Tk and Expect is to download the compiled packages from www.sunfreeware.com. The packages can be added to the system using the command

'pkgadd –d <package-name>'.

If you decide to compile the software on your system: The installation of the software is well documented and should not give any problems. However, a short description for installation of the software packages on Sun computers will be given here. Future updates might require some modifications, also note that the version numbers in the file and directory names of the system software will change. The installation of Tcl, Tk and Expect will be defined by the configure script, the settings (like path settings) can be set through switches; help can be obtained with 'configure –help'. The sequence for installation of the software should be 1-Tcl, 2-Tk, 3-Expect and 4-Kermit.

The ncftp program can be used as an alternative for data transfer (station types: QNXSEISLOG and FTP) instead of the standard ftp program. This may be useful to handle firewalls. A pre-compiled version of the software can be obtained from the web site given above.

Installation of Tcl

- copy the file tcl8.0p2.tar.Z for example to directory /usr/local/source
- uncompress the file with
  uncompress tcl8.0p2.tar.Z
- the file tcl8.0p2.tar is unpacked with
  tar xvf tcl8.0p2.tar
- change to directory tcl8.0/unix
- install the software
  configure --enable-cc
  make
  make install
- change to directory /usr/local/bin and make link
  ln -s tclsh8.0 tclsh
- change to directory /usr/local/lib and make link
  ln -s tcl8.0 tcl

Installation of Tk

- copy the file tk8.0p2.tar.Z for example to directory /usr/local/source
- uncompress the file with
  uncompress tk8.0p2.tar.Z
- the file tk8.0p2.tar is unpacked with
  tar xvf tk8.0p2.tar
- change to directory tk8.0/unix
- install the software
  configure --enable-cc
  make
  make install
- change to directory /usr/local/bin and make link
  ln -s wish8.0 wish
- change to directory /usr/local/lib and make link
  ln -s tk8.0 tk

Installation of Expect

- copy the file expect.tar.Z for example to directory /usr/local/source
- uncompress the file with
  uncompress expect.tar.Z
- the file expect.tar is unpacked with
  tar xvf expect.tar
- change to directory expect-5.28
- install the software
  configure --enable-cc
  make
  make install
- change to directory /usr/local/lib and make link
  ln -s expect5.28 expect

Installation of Kermit

- copy the file ckermit.tar to directory /usr/local/source/kermit
- change to directory /usr/local/source/kermit
- unpack the file
  tar xvf kermit.tar
- example for Solaris 2.x, compile with
  make solaris2x
- copy file wermit to file /usr/local/bin/kermit
- change the mode
  chmod 755 /usr/local/bin/kermit
- copy file ckuker.nr to file /usr/man/manl/kermit.l
- change to directory /usr/local/bin
- change owner
  chown uucp kermit
- change mode
  chmod u+s kermit

3.2 Installation of SEISNET

Before the installation of SEISNET, the SEISAN Version 8.0 (or higher) software needs to be installed. SEISAN is running on the operating systems Solaris and Linux. Therefore SEISNET only can be installed on these systems. However, it is only well tested on Solaris.

In case you are upgrading your version of SEISNET, you should take a backup before the new version is installed. Parameter files are not overwritten, which means that you can install the new version on top of the old one. However it might be safer to rename the old SEISNET top directory, and then to install the new version. The parameter file has changed. Therefore it is suggested to copy the example parameter file (EXP/seisnet.par_org) to seisnet.par (or another name) and do your modifications to this file. You should also check the files COM/.SEISNET_org and EXP/seisnet_cron.par_org.

The SEISNET software is distributed as compressed tar file. The software is compiled on Solaris 2.7 (seisnet.solaris.tar.Z) and Linux Redhat 6.0 (seisnet.linux.tar.Z). For compilation of the Fortran programs, the SEISAN archive and include files have to be installed. SEISNET can be installed in any directory, however it is recommended to install SEISNET under a top directory, which must not be the same as the SEISAN top directory. If SEISAN is under seismo, SEISNET could be

under SEISNET, this name will be used in coming examples.

First the file is uncompressed:

uncompress seisnet.sun.tar.Z

Then the files are restored from the tar file:

tar xvf seisnet.sun.tar

Now the SEISNET directories and files are extracted.

Before SEISNET can be used, the paths for the EXP and PRO directory have to be added to the path definition in the .cshrc file. This is done by editing the .SEISAN file in the the SEISNET/COM directory and sourcing it in the .cshrc file. Alternatively the path settings can be added to the .SEISAN file.

SEISAN databases

For every station in the parameter file a database has to be created using the SEISAN program MAKEREA (see SEISAN manual). In addition the log database and the central database have to be created.

After installation and modification (next steps), SEISNET can be started with 'seisnet'.

3.3 Setup of SEISNET

Files that have to be modified or made are:

EXP/seisnet.exp
EXP/seisnet.par
EXP/seisnet_cron.par
COM/.SEISNET

EXP/seisnet.exp:

`#!/usr/local/bin/expect --` in the first line of the script the path and name of the Expect program is given in order to run the script as a program, to find the path to Expect on your system type 'which expect', note: although '#' indicates a comment, the line MUST be written as shown

COM/.SEISNET (copy from .SEISNET_org) :

After this file is sourced, SEISNET can be started with the command 'seisnet', which is an alias. If more than one parameter file is used, several aliases can be defined. An example file is seen below:

```
#!/usr/bin/csh

#
#   SEISNET definitions to be sourced from users .cshrc file
#   NOTE: this file will not be executed when running SEISNET as a cron job,
```

```
#   parameters are then set in seisnet_cron.par, noramlly located in /EXP

#
#   SEISNET top directory
#

setenv SEISNET_TOP /net/seismo/seismo/SEISNET

#
#   set SEISNET EXPECT directory
#

setenv SEISNET_SOURCE /net/seismo/seismo/SEISNET/EXP

#
#   useful aliases
#
#   normal seisnet command
#

alias seisnet '$SEISNET_TOP/EXP/seisnet.exp -pf $SEISNET_TOP/EXP/seisnet.par'

#
#   another SEISNET process
#

alias cjmi '$SEISNET_TOP/EXP/seisnet.exp -pf $SEISNET_TOP/EXP/jmicont.par'

#
#   continuous data
#

alias cont        '$SEISNET_TOP/EXP/seisnet.exp  -pf $SEISNET_TOP/EXP/cont.par'

#
#   command to go to EXP directory
#
alias sn          'cd $SEISNET_TOP/EXP'

#
#    add path to SEISNET programs
#

set path=($SEISNET_TOP/PRO $path)
```

It is necessary to define the environmental variable SEISNET_SOURCE, which points to the EXP directory containing source files that are loaded when SEISNET starts. Also, the SEISNET/PRO directory needs to be added the PATH definition.

The Parameter File (EXP/seisnet.par)

See EXP/seisnet.par_org for an example, copy this file to EXP/seisnet.par if new installation.

In SEISNET all parameters are defined in a single file. The parameter file is used by the SEISNET Expect script and other Fortran programs. The name of the parameter file is given to SEISNET as argument each time SEISNET is started. The parameter file contains the name of another parameter file that is to be used when running SEISNET as a cronjob, which defines the setup of the environment.

The parameter file is an Expect script and parameters are set directly using the 'set' command. Parameters are used within the SEISNET script by sourcing the parameter file. The parameter file is also used by the SEISNET FORTRAN programs. In the Fortran programs, the file is read and parameters are extracted. This is why the parameters have to be given exactly according to the format description given below.

An example of the parameter file is given with the distribution (EXP/seisnet.par_org), comment lines start with '#'. If the value of a parameter consists of more than two words, separated by blank

characters, quotes have to be used, e.g. "Mo i Rana".

The parameter file can be checked with option 11-2 when starting SEISNET interactively.

General format of SEISNET parameter file:

col 1 - 3 : Expect command 'set'
col 5 - 29 : parameter name
col 31 - 80 : parameter value

The SEISNET parameters can be divided into five groups: general parameters, auto processing parameters, waveform transfer parameters, AutoDRM parameters and station parameters:

General Parameters (parameters that have to be set are bold, others are optional and will have suitable default values)	
AFTP_HOME_DIR	home directory of anonymous ftp on the central server, used for Nanometrics NAQS, e.g. /local/aftp
AFTP_INCOMING_DIR	the path to the anonymous ftp incoming directory, under AFTP_HOME_DIR, used for Nanometrics NAQS, e.g. incoming
CENTRALDATABASE	events declared by the EVENT program will be put into the SEISAN database defined by this parameter
CRONPARAMETERFILE	name of additional parameter file, which will be used if SEISNET is started with the option '-cr', which is required to run SEISNET as cronjob
DATABACK	gives the maximum number of days before current date, only detections within these days will be transferred
FTPPROGRAM	name of ftp program (ftp or ncftp), ncftp can be used only with QNXSEISLOG or FTP station type
EVENTDETECTION_ DIRECTORY	this directory will contain single detection files that are then merged into network events
HOMEDIRECTORY	name of user's home directory, useful, since then this can be used as variable inside the parameter files, see example
INSTITUTENAME	name of your institution
KERMITLINE	device name of modem line used for Kermit, see /etc/remote file, and kermit man pages
KERMITMODEM	type of modem used for Kermit, e.g. hayes
KERMITPARDIR	directory which holds Kermit parameter files
LOCKFILES	name list of lockfiles that are set by the user and used with SEISNET when operating either interactively or as a cron job. This way, SEISNET, when running interactively, will know about the names of lock files defined and the user is then able to manually list and delete them.
LOGFILEDIR	directory that contains logfiles
LOG_EMAIL_LIST	email addresses to which summary logfile is send
LOGFILESTARTHOUR	hour at which logfile starts and stops
LOGFILE_ STATIONORDER	order in which nodes are to appear in the summary logfile
MAILPROGRAM	name of command line based email program (Mail, xmail, …)

NAQS_EXTRACT_CLIENT	path to the Nanometrics Extract client, the Java application to extract data from a Nanometrics NAQS
NUMBEROFSLOTS	number of slots for parallel transfer, the idea is to define slots for groups of stations, on one slot data from a number of stations is transferred in series, while several slots are running in parallel, see option '-ts'
NUMBEROFSTATIONS	number of stations in parameter file
OPERATOR	operator code, maximum three characters, used by split program, will be written in S-file
OS	operating system on the central computer SOLARIS, SUNOS or LINUX
PRINTLOG	If daily summary logfiles should be printed automatically, this parameter has to be set to 'YES'
PSPRINT	name of printing command for printing ASCII files on a PostScript printer
REPEATSTATION	definition of how many times, in case of errors, data transfer will be done for a station
SEISNETEDITOR	name of editor that will be used by SEISNET
SEISNET_EMAIL	SEISNET user's email address, used for AutoDRM and as password for anonymous ftp
SEISNET_NAME	name of this SEISNET parameter set, this will be shown when SEISNET is running; useful, if more than one parameter file is in use
SEISNET_OPERATOR_EMAIL	e-mail address of the Seisnet operator/administrator (currently not used)
SINGLE_LOG	specifies, if log is created for every single connection
STATIONPARAMETERSUN	this directory will have station subdirectories used for changing of parameter files on SEISLOG stations, remember to create these directories
TIPMODEM	name of modems used by tip program, see /etc/remote file, and tip man pages, could be e.g. "/dev/cua/a /dev/cua/b" (several can be given).
WAVEBACK	requests for waveform data are only made for this number of days before the current date, note that this can be different from DATABACK
WAVEFORMREQUEST_ DIRECTORY	directory that contains single file waveform data requests, request files deleted when files are transferred
WORKDIRECTORY	directory that will be used when SEISNET is running, waveform files and temporary files will be put into this directory
Auto Processing Parameters	
ALERT_EMAIL_ADDRESS	email address to use when sending out the alert message, this may be an email list server address; also, several addresses can be separated by comma like abc@test.com,efg@some.org
ALERT_EMAIL_MIN_MAG	minimum magnitude required to send out an alert
AUTOLOCATE	set to YES, if SEISNET should do automatic location
AUTOPICK	name of program to use for autopick (AUTOSIG or AUTOPIC)
EVENTTIMEWINDOW	array propagation window, number in seconds, within which station detections will be associated to one event, (used by the EVENT program)
MINIMUMTRIGGERS	minimum number of triggers used by the EVENT program, if within the time window there are at least this number of triggers,

	an event will be declared, can be set to '1' to make every station trigger a network trigger and all waveform files are transferred.
PROCESSINGDAYS	number of days before current date, used by the EVENT program, only data within these days will be used for event detection, note this can be different from DATABACK
AutoDRM Parameters	
AUTODRMLOCK	name of lock-file to be used with AutoDRM options
AUTODRMMAIL	name of file to which incoming mail will be saved
AUTODRMSLEEP	used by the AutoDRM watch option in SEISNET, time in seconds, the watcher shall wait for before lock-file is checked the second time
AUTODRMWORK	work directory for AutoDRM options
BACKUPMAILCOMMAND	command to make a backup of the incoming mail, since it will be deleted by the SAVEMAILCOMMAND
MAILFILE	name of file with incoming email
SAVEMAILCOMMAND	command to save mail to file; AUTODRMMAIL can be used as variable for the file, the mail is saved to
Parameter for Master Mode All types of seismic nodes in SEISNET can be set as MASTER stations. This is done by adding to the respective station parameter setting the parameter MASTER:	
MASTER(i)	YES
Note: • For the stations that are not MASTER stations, it is not necessary to set the MASTER(i) variable to NO • Command line option –mm also needs to be specified when SEISNET is started	
General station parameters (the following parameters are common for all node type *i = station index, between 1 and NUMBEROFSTATIONS)* *See node specific parameters below*	
ACTIVE(i)	set to 'YES', if station is used for parametric data transfer
DATABASE(i)	name of SEISAN station database, max 5 characters, '_' if less than 5 chars not required ??? station can be XX ?
EVENTDETECTION(i)	set to 'YES' if station should be used for network event detection, NO if not. If option is NO and WAVEFORM is YES, waveforms will be transferred butS-files will only be created in the station data base for this node instead of the central data base). This setting can be used to get waveform data for all detections from this node.
EXTRACTDATABASE(i)	database name into which the S-files for the automated extracts are put.
EXTRACTTIME(i)	specify time windows (one or several) for automated extract, useful for example for noise extract; time is given as hhmm; exmpale: "0500 1700"; works for QNXSEISLOG, IRIS and

	AUTODRM
EXTRACTDURATION(i)	duration of extract windows in seconds starting at EXTRACTTIME, there has to be a value in EXTRACTDURATION for every start time in EXTRACTTIME; example: “60 120”
FORCEDETECTION(i)	Set to YES if all detections from node should be used to overwrite criteria in event detection, this means that all data from this node will enter the central data base and get transferred.
LOGIN(i)	Login
NUMBER(i)	number of station (IP address or phone number)
PASSWORD(i)	Password
STATION(i)	station code, maximum 5 characters
STATIONNAME(i)	station name
SYSTEMTYPE(i)	possible options are: AUTODRM, FTP, IRISA, IRISB, NAQS, QNXSEISLOG, QUAKE, SDAS, SEISAN, VMESEISLOG
TRANSFERSLOT(i)	in the instant waveform transfer. this parameter defines which slot should be used for the respective station, i <= NUMBEROFSLOTS
WAVEFORM(i)	set to ‘YES’ if waveform data should be transferred. In case of a detection in central data base, that is only if EVENTDETECTION is set to YES. If EVENTDETECTION is set to NO, the waveform data will be transferred, but registered under the station data base.
Parameters for AutoDRM Nodes	
AUTODRMADDRESS(i)	the email address of the AutoDRM
COMPONENTS(i)	definition of the components for data transfer, col 32 - 64 : components (*, bhz, sh*, …) col 66 – 71 : pre-event memory col 73 –78 : time window in seconds
Example of this COMPONNET line: 12345678901234567890123456789012345678901234567890123456789012345678901234567890 set COMPONENTS(8) "* 60 500 "”	
SYSTEMTYPE(i)	AUTODRM
Parameters for FTP Servers Stations	
COMPRESSWAV(i)	set to “YES” to activate compression AFTER waveform file transfer; gzip will be used if available (not on Windows Seislog)
CONNECTION(i)	INTERNET
CONVERSIONPROGRAM(i)	name of conversion program to be used for data from FTP server. If data is not to be converted, write NONE. If the ftp server is a Windows Seislog, system subtype winseislog (for winseislog only the ringbuffer file names are changed if set for continuous file transfer, for event files use systemtype SEISAN). Conversion programs tested are: qnxsei, os9sei. NOTE, other conversion programs need to follow the same IO syntax as qnxsei.
FILENAMEPATTERN(i)	pattern of waveform files, ‘?’ is used as wildcard; example: “????_??_????_??T.???_??_1”
FILENAMEYEAR, FILENAMEMONTH, FILENAMEDAY, FILENAMEHOUR, FILENAMEMIN, FILENAMESEC	

	definition of date and time in waveform file name col 32 – 34 : index of character from col 36 – 38 : index of character to ***Example:*** *9208_13_0845_01…* 12345678901234567890123456789012345678901 set FILENAMEYEAR(11) " 1 2" set FILENAMEMONTH(11) " 3 4" set FILENAMEDAY(11) " 6 7" set FILENAMEHOUR(11) " 9 10" set FILENAMEMIN(11) " 11 12" set FILENAMESEC(11) " 14 15"
LISTCOMMAND(i)	command used for directory listing on the FTP server
STOPSECBEFORE(i)	only transfer detection information up to number of seconds before now, useful when transferring continuous data, since ringbuffer files may not be completed
SYSTEMTYPE(i)	FTP
WAVEFORMBASE(i)	name of SEISAN waveform database, waveform files will be moved to WAVEFORMBASE after data transfer; set to NONE for disabling this option; this option is useful for transfer of continuous data. NOTE that a station data base must also be made for SEISAN continuous option to work, either with EXTRACTDATABASE or DATABASE depending type of station.
WAVEFORMDIR(i)	directory on the ftp server that contains the waveform files

Station Parameters for IRISA and IRISB Stations

Most Quanterra stations now are what SEISNET calls IRISB, not clear in what version of the Quanterra software this change occurred, but all Multi Shear systems, should be (after 2000) of type IRISB.

Comment: The station type more correctly should be Quanterra Multishear, something to be changed in future.

Note: The parameters for IRISA and IRISB are identical except for the SYSTEMTYPE. This is required, since the log output on the IRISB station is different from IRISA!

BAUDRATE(i)	only used if CONNECTION(i) is 'MODEM', gives the transfer rate for modem connection in baud, can be set to 'AUTO' for default setting
COMPONENTS(i)	gives information about components used. More than one of these lines can be given, used by the FSEISNET program, format is: col 32 - 37: trigger component col 39 - 44: request component, if transfer is BINARY, the component can be set to BH? col 46 - 51: request component col 53 - 59: request component col 61 - 66: request component col 68 - 72: pre event time in seconds col 74 - 78: if ASCII transfer: number of samples (maximum is 9999); if FTP or BINARY transfer:

	length of requested time interval in seconds
Example of the component line (only 1 type (ASCII or BINARY), but several lines for several streams can be used,): 12345678901234567890123456789012345678901234567890123456789012345678901234567890 set COMPONENTS(4) "BHZ :BHZ BHN BHE 60 6000 " (ASCII) set COMPONENTS(7) "BHZ :BH? 60 300 " (FTP, BINARY)	
CONNECTION(i)	INTERNET, MODEM or KERMIT (if you choose Kermit, you need to create a login file for the respective station, see below), for Kermit, both ASCII and Kermit Binary transfer are supported
EXTRACTCOMPONENT(i)	components to be extracted in case EXTRACTTIME and EXTRACTDURATION are set; Example: “00-BHZ", name points to trigger component in COMPONENTS definition
KERMITTYPE(I)	WAIT or NOWAIT, try which one works for your stations, normally NOWAIT should work
SYSTEMTYPE(i)	IRISA or IRISB, see above
TRANSFER(i)	ASCII, FTP or BINARY; ASCII can be used for modem or Internet communication, BINARY can be used with KERMIT connection and FTP can be used with INTERNET connection only
Kermit login file: If you are using Kermit, you need to create a login file which will be used to login to the station using Kermit. Check the files EXP/STAT1.KER and EXP/STAT2.KER, which are examples. First you should know how you manually login to the station using Kermit. Then it should be easy to create the login file. By customising the login file any communication supported by Kermit, is supported within SEISNET. Both ASCII and Kermit Binary data transfer are supported. There has to be one STAT.KER file in the seisnet/EXP directory for each station using Kermit	

Station Parameters for NAQS	
COMPONENTS	List components for which parametric information is to be collected, several lines can be given
Example of COMPOMENTS setting: # Name Pre-event Post-event set COMPONENTS(12) "*.* 10 300 "	
EXTRACTCOMPONENTS	List components for extract of waveform data
Station Parameters for QNX-SEISLOG Station	
BAUDRATE(i)	only used if CONNECTION(i) is ‘MODEM’, gives the transfer rate for modem connection in baud, can be set to ‘AUTO’ for default setting
COMPRESSEDTRANSFER(i)	set to “YES” to activate compressed transfer of waveform files, when active waveform files are compressed using gzip on the QNX Seislog before transmission; for IP stations only
CONNECTION(i)	INTERNET or MODEM
DOWNLOAD_IDXLOG(i)	if the ‘idx_log’ file should be downloaded and processed set to ‘YES’
HANGUP_MODEM(i)	YES or NO, if set to YES, ‘+++’ is send to hangup line after connection is closed
PARAMETERSET(i)	Choice of parameter set, see SEISLOG manual.
PROMPT(i)	login prompt, e.g. ‘EVENTS:’
RESTART(i)	set to ‘YES’, if station should be restarted in case it is not running, used in connection with detection parameter transfer
SYSTEMTYPE(i)	QNXSEISLOG for QNX-SEISLOG station

SYSTEMSUBTYPE(i)	LGS or LS, if set to LGS, in the parameter data transfer the Seislog LGS program is used, if LS, the ls command is used, in exactly the same way as for FTP server stations, this is useful for transferring ring-buffer files from a QNX-Seislog system. If LS is set you need to set the parameters LISTCOMMAND, FILENAMEPATTERN, FILENAMEYEAR, FILENAMEMONTH, FILENAMEDAY, FILENAMEHOUR, FILENAMEMIN, FILENAMESEC, STOPSECBEFORE, see FTP station type for details
TRANSFER(i)	ASCII or BINARY for mode of transfer, only for modem stations
WAVEFORMDIR(i)	Directory in which waveform files are stored on the station
Parameters for QUAKE	
REGION(i)	this parameter can be used to put events from a given region into the central database directly. For these events, based on EXTRACTSTATION, waveform request lines are also made for the stations defined with EXTRACTSTATION; the format is “min_lat,max_lat,min_long,max_long, max_mag” or NO in case this option is not wanted. See section 5.3.3 for an example.
Example of the REGION line: 12345678901234567890123456789012345678901234567890123456789012345678901234567890 set REGION(6) "-20,20,60,90,6.0" ; # coordinates or NO	
SYSTEMTYPE(i)	QUAKE for ‘finger quake@…’
SYSTEMSUBTYPE(i)	FINGER or FTP, try out which works best for you.
EXTRACTSTATION(i)	Index numbers of nodes in SEISNET parameter file, several can be given, example: “1 3 4”; extract requests will automatically be generated for events that are within the criteria specified by REGION; station location is taken from STATION0.HYP (see SEISAN manual), if node name is different from station name in STATION0.HYP, give location for node name in STATION0.HYP
EXTRACTDURATION(i)	duration of extract window in seconds

Parameters for SDAS	
COMPONENTS(i)	Pre event time and event duration: col 68 - 72: pre event time in seconds col 74 - 78: event duration in seconds
CONNECTION(i)	INTERNET
PARAMETERSET(i)	Choice of parameter set.
Parameters for SEISAN	
FTP_DATADIR	Directory to change into for ftp login, directory separator or has to be given as ‘\/’, exclude the drive letter. (e.g. “\/seisan”
SYSTEMSUBTYPE	Options: WINDOWSSEISLOG (diskspace and time are checked)
TELNET_DATADIR	Directory to change into for telnet login, directory separator has to be given as ‘//’, exclude the drive letter. (Note: You may have to experiment with this depending on the version of the telnet version, also e.g. “seismo\\wav” can work), needed to get a well defined prompt.

Parameters for VME-SEISLOG	
BAUDRATE(i)	only used if CONNECTION(i) is 'MODEM', gives the transfer rate for modem connection in baud, can be set to 'AUTO' for default setting
CONNECTION(i)	MODEM
HANGUP_MODEM(i)	YES or NO, if set to YES, '+++' is send to hangup line after connection is closed
TRANSFER(i)	ASCII
WAVEFORMDIR(i)	Directory that contains waveform files on the VME Seislog system

Additional parameter file if SEISNET is started as cronjob

If SEISNET is started as cronjob, an additional parameter file (seisnet_cron.par) is needed. See example 'EXP/seisnet_cron.par_org', copy and modify:

Example:

```
#
# IN CASE THE SCRIPT IS STARTED AS A CRON JOB
# A SET OF PARAMETERS HAS TO BE SET
#
#   messsge to screen
puts "setting parameters for autostart ...\r"

#   terminal type
set env(TERM) xterm

#   user starting seisnet
set env(USER) seismo

#   give directory of seisnet script
set env(SEISNET_SOURCE) /net/seismo/seismo/SEISNET/EXP

#   set path for all programs that might be used
set      env(PATH)      ".:/net/seismo/seismo/SEISNET/PRO:/net/seismo/seismo/SEISNET/EXP:/net/seismo-
DVLP/s2000/seismo/PRO:/net/seismo/s2000/seismo/COM:/net/seismo/seismo/PRL:/local/bin:$env(PATH)"

#  show path string on screen
  puts "$env(PATH) \r"

#   SEISAN data base location
set env(SEISAN_TOP) /net/seismo/seismo

#   name of defualt printer used by seisnet
set env(PRINTER) alk
```

4. SEISNET Functionality

4.1 Seismic Nodes in SEISNET

AutoDRM

AutoDRM is a system for seismic data retrieval from seismic acquisition systems or data centers. This is done by requesting data through email from the AutoDRM. The AutoDRM processes the request and sends the data as email or a message that the data can be retrieved through ftp.

At present in SEISNET only the waveform data retrieval through email is supported. The automatic data retrieval in SEISNET works very similar to the design of the AutoDRM. SEISNET can every minute check for incoming email and split into single message files. These files are processed to

identify data sent by AutoDRM and to find the corresponding entry in the SEISAN database. The data is automatically converted and accessible by SEISAN.

FTP server

This expression refers to any seismic node that is connected through TCP/IP and produces or stores waveform files, in which the file name indicates the start time. The set-up for this type of stations is done within the parameter file, which means no software change is required (However, modification or writing of conversion program may be necessary if the data should be readable by SEISAN).

IRIS

The type IRIS refers to the Quanterra data acquisition and retrieval system, more correctly the system type should be called Quanterra. The Quanterra system stores data in a continuous buffer and triggered events in an event buffer. The difference between the two buffers is that the continuous buffer will be overwritten within a shorter time interval, while the data in the event buffer remains for longer. The Quanterra system provides a log of triggers, which is used by SEISNET. Waveform data by SEISNET is always taken from the continuous buffer to avoid the problem of data not being available in the event buffer. For the waveform data transfer Ftp, Kermit and variable ASCII are supported. For Internet communication, Ftp is the fastest and most reliable option. Due to the fact that in the binary transfer whole buffers are transferred, the ASCII transfer is generally faster than binary transfer using Kermit. However, using Kermit as login software, a large variety of communication methods are supported, transfer can be ASCII or Kermit Binary.

Lately the Quanterra system has been changed for the year 2000 and longer component names. This in SEISNET has lead to two types of IRIS systems, IRISA and IRISB.

Nanometrics NAQS

It is assumed that the Nanometrics NAQS system is accessible through TCP/IP. The system provides daily files with event trigger information, these files are transferred using ftp. Waveform data on the NAQS server are stored in a continuous system. Data is extracted from the NAQS server through a Java client application running on the central computer. The extract client sends the request for waveform data to the NAQS server. The server performs the extract and puts the data files onto the anonymous ftp server (central computer running SEISNET) into the incoming directory. **Note** that the anonymous ftp server has to be set-up in order to transfer data from the NAQS server (this can be done with the standard Solaris ftp server or the ncftp server (http://www.ncftp.com/); make sure to follow all security advice on the set-up of anonymous ftp servers). The waveform data is then taken from the aftp incoming directory and put into SEISAN (including file conversion).

Quake

Several institutions provide their near real-time bulletins as .plan file on an account with name ‘quake’. This information can be obtained using the command ‘finger quake@...’. Alternatively the information can be available through ftp. Note, that with this process, as with other nodes, SEISNET is not able to collect data older than what was collected in the previous run. This is normally not a problem with a stand-alone triggered system, but for PDE, data older than the last event could be added at a later time and the database collected by SEISNET would not be complete.
Example from NEIC:

```
[gldfs.cr.usgs.gov]
```

```
Login name: quake                       In real life: see Ray Buland
Directory: /home/quake                  Shell: /home/quake/run_quake
Last login Tue Mar  2 10:37 on ttyp0 from cmpco.com
No unread mail
Plan:
The following near-real-time Earthquake Bulletin is provided by the National
Earthquake Information Service (NEIS) of the U. S. Geological Survey as part of
a cooperative project of the Council of the National Seismic System.  For
a description of the earthquake parameters listed below, the availability of
additional information, and our publication criteria, please finger
qk_info@gldfs.cr.usgs.gov.
Updated as of Thu Apr 1 16:58:44 MST 1999.

 DATE-(UTC)-TIME    LAT    LON     DEP   MAG  Q  COMMENTS
yy/mm/dd hh:mm:ss   deg.   deg.     km
99/03/29 13:18:53  85.57N  86.32E  10.0 4.8Mb B  NORTH OF SEVERNAYA ZEMLYA
99/03/29 14:49:36  33.00N  80.20W   5.0 2.9Lg    <SPEC> SOUTH CAROLINA
99/03/30 00:44:37  52.16N 178.63W 163.5 4.2Mb B  ANDREANOF ISL, ALEUTIAN IS.
99/03/30 09:59:08  10.54N  70.65W  10.0 5.4Ms A  VENEZUELA
```

QNX-SEISLOG

The SEISLOG system, in case the system triggers, creates event files and writes parametric data to a trigger logfile, which can be extracted with the LGS program. In addition, SEISLOG writes data to a continuous ring buffer file system. SEISNET takes parametric data from the output of the LGS program or from the LS command depending on the SYSTEMSUBTYPE (LGS or LS). In the waveform data transfer, SEISNET transfers files directly as binary or after conversion as ASCII. The waveform transfer using Internet supports compression, using gzip/gunzip which may have to be installed on the Seislog and the central computer.

SDAS (Simple Data Acquisition System)

SDAS is an acquisition system running under QNX developed at the British Geological Survey for geomagnetic and seismic data. The system has been interfaced to a number of digitisers that can be connected to one SDAS in parallel. SDAS continuously writes data to disk and performs event detection.

SEISAN

Data kept in a Seisan database can be extracted through SEISNET. Both event detection and extract from a continuous database are supported. Events in the SEISAN database are treated as if they were detections on a seismic network.

VME-SEISLOG

The VME Seislog was the predecessor of the QNX Seislog. There are not too many systems of this type around and they will soon disappear. The system works similar to the QNX Seislog, trigger information is taken from the LGS output and waveform data is transferred using the AUTOASC program. SEISNET only supports modem communication.

4.2 Interactive Menu

For interactive use, the software is started with the command ‘seisnet’ (Seisnet is an alias set up in COM/.SEISNET). The user will be able to choose from a set of menu options. It is possible to select more than one option by leaving a blank character between the options, for example ‘1 2’ will start parametric transfer and event detection.

The interactive menu looks like this:

```
SEISNET - Version: 2.3.0   Date: 21/11/2001 --- Seisnet Parameter File

 ( 1) Transfer parametric data
 ( 2) Network event detection
 ( 3) Start automatic processing
 ( 4) Transfer waveform data
 ( 5) Instantaneous waveform data transfer for selected event
 ( 6) Extract waveform data submenu
 ( 7) Get detections, event detection and waveform transfer
 ( 8) Login to station
 ( 9) QNX Seislog submenu
 (10) AutoDRM submenu
 (11) SEISNET parameter file and settings
 (12) Logfiles
 (13) Seisnet processes and lockfiles

 ( q) Quit

 choice ?
```

Description of the menu options

4.2.1 Transfer parametric data

This option is to transfer parametric data from seismic nodes that are specified in the parameter file. The user can select one, several or all stations for data transfer. The ACTIVE parameter does not apply in interactive mode. Depending on the node and connection type this routine connects to the nodes and gets parametric data. Only new parameter data will enter the database.

Different combinations of station and connection type are supported. In case of an error in the transfer of data from a certain station, depending on the parameter ‘REPEATSTATION’ in the parameter file, the transfer routine starts again for this station.

How this works

The parametric data, depending on the node type, is converted to SEISAN S-file format, one S-file per detection. Information about waveform data is included in the S-file in a type 3 line. This information is used to create requests for waveform data transfer in case an event detection. The S-files are put into a SEISAN station database. There has to be one database per station. In case a node is set for network event detection, the S-file is copied to the network event detection directory. If a node is not set for network detection, but waveform data transfer, a request file is created in the waveform data request directory at this stage.

Examples of S-files generated by parameter transfer:

```
 2001 11 1  017 40.9 R                        KON  1                              1
 ACTION:NEW 01-11-01 02:04 OP:aut  STATUS:               ID:20011101001740     I
 NET WAV EVE KONO IRI 00-LH?2001/10/31 23:47:40  9000                      REQ 3
 STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7

 2001 12 6 1640 47   R                        LNQ  1                              1
 ACTION:NEW 01-12-10 11:48 OP:aut  STATUS:               ID:20011206164047     I
 NET WAV EVE LNQ  QNX 2001_12_06_1640_27T.LNQ_13_1                         REQ 3
 STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7
```

FTP:
A simple file listing is done using the LISTCOMMAND to obtain the list of events.

IRIS/GSN:
The 'l' command is used to obtain the list of triggers.

NAQS:
The system provides daily files with event trigger information, these files are transferred using ftp.

QNX-SEISLOG:
There are two options, either the 'lgs' program on the Seislog is used to obtain the trigger list, or the 'ls' command is used. The method (lgs or ls) is specified by the SYSTEMSUBTYPE variable. The 'ls' mode has to be used for continuous file transfer.

In addition, after login to the station, it is checked if the station is running using the ACTIVE program. If the station is not running and the 'RESTART' parameter for this station is set to 'YES', the station is restarted using SYS_BOOT (no parameter data are transferred). In addition, the station CPU time is compared to the time at the centre and the disk space is checked.

Optionally, the station and clock uptime for the previous day can be determined by transferring the idx_log file from the station. Then the LOG_IDX program is started to read the idx_log file and to create daily log files for respective days in the station database. The information on the status of the station is written to the daily logfile. From these daily logfiles it can be seen, if a station has been running. The program STALOG (SEISAN) can be used to produce monthly statistics.

QUAKE:
Either 'finger quakeQ@…' or a transfer of the quake-list using ftp is done, the transfer method is selected with the SYSTEMSUBTYPE variable.

SDAS:
The list_events command is used to obtain a list of triggers.

SEISAN:
Event data is extracted using the collect program, which creates a file remotely. This file is then transferred using ftp and written out to the station database.

VME-SEISLOG:
The 'lgs' command is used to get the trigger list.

4.2.2 Network Event detection

For network event detection, parametric data from individual nodes are associated and merged into the central database. This is done by the EVENT program. The program reads detection information from the event detection directory and also events from the central database. The list

of detections from all stations is sorted in time. Detections from different stations, which are within a given time interval are declared as network events and put into the central database. Single detection files are deleted after they are merged into network events. In case the minimum number of triggers is not reached, the single detection files will remain until deleted manually. The user should delete files older than e.g. one month.

4.2.3 Start Automatic Processing

This option starts the automatic processing, which is the automatic phase identification using AUTOSIG or AUTOPIC and the epicenter location using HYPOCENTER. The result is written to central event data base.

4.2.4 Transfer waveform data

This function transfers waveform data from the seismic nodes.

How this works

Waveform requests, generated by SEISNET, are given as single files in the waveform request directory. Waveform data are transferred for all requests and immediately converted to SEISAN format. In case of error free transfer and conversion, the event file is updated and the request file is deleted. In the request line (in S-file), it will be shown that the data are transferred and the SEISAN waveform filename will be added to the file. If an error occurs or when all data are transferred, the connection is closed and data for the next station will be transferred. In case of an error in the transfer of data from a certain station, depending on the parameter 'REPEATSTATION' in the parameter file, the transfer routine will be started again for this station. If the data will not be available for transfer in future, the request is deleted. This is determined by SEISNET by checking the remote system e.g. a ring buffer can be overwritten, of waveform files deleted.

Example of update:

before transfer:

```
2001 1212 1052 38   R                        LNQ  1                              1
ACTION:NEW 01-12-12 15:05 OP:aut  STATUS:               ID:20011212105238     I
NET WAV EVE LNQ  QNX 2001_12_12_1052_18T.LNQ_13_1                          REQ 3
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7
```

after transfer:

```
2001 1212 1052 38   R                        LNQ  1                              1
ACTION:NEW 01-12-12 15:05 OP:aut  STATUS:               ID:20011212105238     I
NET WAV EVE LNQ  QNX 2001_12_12_1052_18T.LNQ_13_1                          TRA 3
NET WAV EVE LNQ  QNX 2001-12-12-1052-18S.LNQ___013                         ASI 3
2001-12-12-1052-18S.LNQ___013                                                 6
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7
```

In the S-files, the following codes are used (col 76-78) to indicate the status of data transfer:

REQ: Waveform file requested
TRA: Waveform file transferred

ASI: Waveform file ready for auto processing
NEV: Waveform file cannot be transferred due to error at node, no further attempt will be made.

AutoDRM:
A request for the selected waveform data is send to the AutoDRM. SEISNET waits for the data to arrive on e-mail and puts into the database. FTP transfer is not supported.

IRIS / GSN:
Data is extracted from the continuous buffer. Data can be transferred as miniseed (ftp or Kermit) or as variable ASCII (modem or kermit). For modem stations, the variable ASCII is faster than the Kermit transfer, since in the binary transfer complete blocks of data and hence a larger amount of data is transferred. The main disadvantage of the ASCII transfer is that the number of samples is limited to 9999. It is possible to define a station twice, once for ASCII and once for BINARY transfer, where the parameters for automatic transfer are set to YES for the ASCII and NO for the BINARY station. The second defined station should get a different name, otherwise the component definition has to be omitted. Then the BINARY station can be used to manually extract larger time intervals.

NAQS:
The extract client tool is used to transfer the data from the NAQS server. The data is pushed onto the aftp server (running on the central computer) by the NAQS server. The data are taken from there and converted using nansei.

SDAS:
The extract program is used to create GSE files on the remote system. The file is then transferred and converted using wavetool.

SEISAN:
Event files are transferred using ftp. On the SEISAN system, the program ' wavfullname' (SEISAN version 8 or higher) has to be installed, which returns the full path to a waveform file. For data extracts, the SEISAN program 'wavetool' is used, and then the data transferred with ftp.

QNX-SEISLOG:
For QNX stations data are transferred from the events directory. For IP stations, ftp is used. For modem stations, either the 'ascc' program is used (ASCII data are captured from the standard output) if the TRANSFER is set to ASCII, or Kermit is used if the TRANSFER is set to BINARY.

Windows-SEISLOG
The station is essentially a SEISAN type.

VME-SEISLOG:
Data is transferred using autoasc on the VME Seislog. Data is converted to Seisan using os9sei.

4.2.5 Instantaneous waveform data transfer for selected event

This option starts the program SEVEN (for select event), which is used to select (by moving to an event in the database and pressing 'sel') an event for instantaneous waveform data transfer. This might be useful in case the parametric data is transferred and the waveform data is needed in the shortest possible time interval. Waveform data can be transferred serial (one station after another) or in parallel (many at the same time in parallel). For the parallel transfer check the variables NUMBEROFSLOTS and TRANSFERSLOT(i) in the parameter file. See also section 5.3.

4.2.6 Extract waveform data submenu

This option is useful to extract additional waveform data from seismic nodes that have not detected some event. At present this works for IRIS, QNX Seislogs, VME Seislog, SEISAN, SDAS and AutoDRM.

The options are:

```
ADDITIONAL DATA SUBMENU
=======================

( 1) Create new event
( 2) Add data from additional stations to existing event
( 3) Extract list

( b) back
```

(1) has to be used if there is no entry in the data base
(2) starts the program SEVEN that makes it possible to select some event from the database.
(3) Create extract list, takes Extract parameters from SEISNET parameter file and creates request files for the extract; could be used for noise extract or continuous data transfer

The function (2) works for both local and teleseismic events. If the origin time and hypocenter are known, the program calculates the arrival times and takes care of the pre event memory, which can be given for each node in the SEISNET parameter file using parameter COMPONENT. Calculation of arrival times for teleseismic phases is based on the IASP91 tables, while for local distances the layered SEISAN velocity model (for example STATION0.HYP) is used. This option works similar to the SPYDER system. If e.g. PDE data enters the data base, these PDE events alone can be used as criteria for data extraction from the field stations.

If the hypocenter is unknown, but the expected arrival time is known, the program will take the input time as fixed arrival time for all stations.

4.2.7 Get detections, event detection and waveform transfer

This option can be used to start the complete data transfer, including transfer of detections, event detection and waveform data transfer. This can be done for one station, a few selected stations or all stations. This function might be useful to quickly transfer data for a few stations that are close to the epicenter in case an earthquake is reported felt.

4.2.8 Login to station

This function can be used to login to a station.

4.2.9 QNX Seislog submenu

This will open up a submenu for QNX-SEISLOG stations:

(1) FTP QNX station

An FTP connection to a SEISLOG system is established.

(2) Check station time/running

This is a function to check if a QNX-SEISLOG station, that is connected to Internet, is running. The first step is to login to the station. The station time is obtained from the date command and compared to the time on the central computer.

(3) Change station parameter files

This function can be used to change the parameter files param1a and param1b on SEISLOG stations that are connected to Internet. The parameter files are transferred from the station to the central computer and put into a station directory under the directory given by the variable 'STATIONPARAMETERSUN'. The station directories have to be created manually before this function can be used. The name of the directory has to be the same as given by the parameter 'STATION'. After transfer, the files can be changed on the central computer. Then the parameter files can automatically be transferred back to the stations and the station can be restarted to use the changed parameter files.

(4) Test modem connection

This can be used to test a modem connection to a SEISLOG system.

(5) Download and process IDX log files from all stations

This option is to download and process the log_idx file from the QNX-SEISLOG and provides station up and down time. Note, this can also be done in non-interactive mode.

4.2.10 AUTODRM submenu

This will open up a submenu.

(Not much to be explained here, normally SEISNET will be set to continuously check for incoming AutoDRM data)

4.2.11 SEISNET parameter files and settings

This will open up a submenu.

(1) edit SEISNET parameter file
Start the editor to modify the parameter file from here.

(2) check SEISNET parameter file
This option runs a check on the parameter file and shows possible errors.

(3) change modem
Select modem from list given by TIPMODEM parameter

4.2.12 Logfiles

Edit and print both log- and summary-log-files.

4.2.13 Seisnet settings, processes and lockfiles

The submenu is:

```
( 1) list lockfiles
( 2) delete lockfiles
( 3) create all lockfiles
( 4) change modem
( 5) list processes
( 6) remove process
```

(1) can help to find out the status of the lockfiles that are given by the parameter LOCKFILES as well as the numerous lock files created temporarely by SEISNET, while (2) can delete them. If you want to lock all processes (for example to stop active cronjobs from running), this can be done with (3). (4) allows to change the choice of modem. (5) and (6) help to list and delete processes that were started with the option '-id' (Options 5 and 6 are still tested and not reliable yet).

5. Background operation of SEISNET

5.1 Cron

On Unix systems, commands can be run in the background at given times (system time, not GMT) using cron. Cron is a program, which continuously executes jobs at user specified times. Normally, all the user has to do is to specify the desired jobs in the users crobtab file, see below. It might be possible that the user does not have the permission to set up a cron job. For setup of cron, like permissions, the user is refered to the man pages (man cron). Useful commands are:

'crontab –e'	edit crontab file, using editor which is set through environmental variable EDITOR (environmental variable)
'crontab –l'	shows contents of crontab file

When a process is started as cron job, the environmental settings are generally unknown. Therefore, in SEISNET it is required to provide these settings, which is done in the file 'seisnet_cron.par'.

Each time the cron job is running, it generates output. If the output is not redirected, an email will be sent to the user. To avoid this, you can redirect the output into a file or to /dev/null. Examples will be given below.

5.2 Lock files

To achieve continuous or near real-time operation, lock files are used so that the same process only starts if the previous run is finished. In the first run, the lock will be created in the seisnet work directory, and the lock will be removed after the process is finished. In addition, individual lock files are created for parameter and waveform transfer. This is for example to avoid that two background processes attempt to transfer data from one station at a time. Each such lock file will automatically get a name related to the station name. There is thus two kinds of lock files:

- user defined lock files associated with a whole run of SEISNET
- lock files associated with individual SEISNET processes, name assigned by SEISNET

If before the first process is finished, the same process is started, it will find the lock and quit. In SEISNET it is possible to use different locks for different processes, since the name of the lock file

is an argument to SEISNET. The only problem occurs, if for some reason a process crashes (it might be the system going down), since then the lock won't be deleted. That is why another process is needed to watch a lock file, a lock watcher. This process will remove a lockfile (name given by user) if it does not change within a given time (duration). The lock watcher program is the same seisnet program started with a special flag. It is up to the user to set the start time and duration and it is important that the watcher should not be started while another watch for the same lockfile is active. In other words, the time interval between cron jobs looking for locks, must be larger then the duration for which a lock is watched.There also has to be enough time for the real process to finish, which means the watcher should be started in rather big intervals. In case of problems, and if SEISNET apparently does not run, the lock files have to be deleted manually. This can be done with SEISNET option 13. Note that names of user defined lock files have to be set in parameter file (parameter LOCKFILES). Lockfiles created by SEISNET processes will be removed automatically after some time, however, they can also be deleted with option 13.

5.3 Starting SEISNET in non-interactive mode as cron jobs

Most of the SEISNET functions can be started in non-interactive mode by giving switches on the command line. This is not very practical for interactive use, but has to be done, if SEISNET is running as cronjob. This will be the case in almost any routine application of SEISNET, since then SEISNET will be automatically started in the background.

Overview of switches (try seisnet –help):

```
Seisnet 2.3
Usage: seisnet [switches]
Available switches:
 -au          start Seisnet in non-interactive mode
 -ai          process incoming autodrm data
 -ap          start automatic processing
 -aw          start autodrm watcher
 -bg          puts Seisnet into the background
 -cr          run Seisnet as cronjob
 -ed          start event detection
 -el          process extract list
 -h or -help help
 -id text     define process id
 -lf file     define name of lockfile
 -li          start download/proceesing of log_idx on QNX
 -lw time     time in seconds to use in lockfile watch mode (duration)
 -mm          master mode, only use MASTER stations
 -ms number   specify modem to use explicitly
 -pd          start transfer of parametric data
 -pf file     give name of parameter file
 -ts number   specify transfer slot explicitly
 -version     show version of Seisnet
 -wd          start transfer of waveform data

NOTE: To start one of the automatic options, the switch -au has
      to be given.  If no option is given, Seisnet will start in
      interactive mode.
EXAMPLE: To start Seisnet non-interactive to perform transfer of
         parametric data, event detection, waveform transfer and
         automatic processing as cronjob:
         1  3,20  *  *  *  NSEISNET/seisnet/seisnet.exp  -au  -cr  -pd  -ed  -wd   -ap  -pf
/net/seismo/seismo/SEISNET/EXP/seisnet.par -lf lock1 > /dev/null
```

The switches can be given in any order and give flexibility on what operations of SEISNET are carried out. Some examples are:

1) SEISNET is running as a data collection system only a few times a day, fast response is of no

importance. If several transfer slots are defined, specify which one to run with option '-ts'. In this case, SEISNET would be started through an entry in the crontab file like this:

5 5,17 * * * seisnet/EXP/seisnet –id ABC –cr –au –pd –ed–wd –ap –ts 1 –lf lock1 –pf <parameter-file> > /dev/null
1 4,16 * * * seisnet/EXP/seisnet.exp –cr -pf <parameter file> -lf lock1 -lw 8000 > /dev/null

The cron job starts running in the user's home directory at 05:05 and 17:05 every day, which means it is possible to give the relative path to seisnet.exp. The path (relative or absolute) has to be given, since when the cron job starts all environmental settings are unknown.
The output from the process is discarded. In order to keep the output, it is possible to redirect to a file like "> seisnet.log". This file will be overwritten each time the cron job is running. Also note that this file can get very large since all output goes there.

The second line in the example above starts the lockfile watcher. The use of the lockfile watcher is important, since otherwise lock files, for example if there is a reboot while SEISNET is running, can remain and will prevent SEISNET from starting again, unless the lockfile is deleted. See section on lockfiles above.

2) Near real-time operation: SEISNET monitors one master station every minute and starts the data transfer in case of a detection:

call master station every minute
* * * * * seisnet/EXP/seisnet.exp -pf <parameter-file> -cr -au -mm -pd -ed –ws WAV1 –wd -lf lock1 > /dev/null
start the lock watcher every hour at minute 5
5 * * * * seisnet/EXP/seisnet.exp –cr -pf <parameter file> -lf lock1 -lw 3400 > /dev/null

3) For use of AutoDRM data retrieval, note that it is not necessary to specify a lock file, since it is already done in the parameter file (AUTODRMLOCK):

check incoming mail box every minute, convert if data and update database
* * * * * seisnet/EXP/seisnet.exp –cr -pf <parameter file> -au -ai > /dev/null
autodrm watch to remove old lock files
1,21,41 * * * * seisnet/EXP/seisnet.exp –cr -pf <parameter file> -au -aw >/dev/null

Deleting of old files

The find command can be used as a crontab entry to automatically delete files that are a ceratin number of days old. For example, in order to automatically delete old event detection directory S-files:

```
05 * * * * /usr/bin/find /seismo/SEISNET/EVENTDET/ -mtime +10 -type f -name '*' -exec \rm -f {} \; >> /dev/null
```

These are just some examples. For details of how to set the processing time, use man crontab. Due to the option of mixing the different switches the amount of possible start-up configurations is immense.

What to do if SEISNET does not work

- Check crontab file
- Check the log files
- Try to run Seisnet interactively, giving the same command as used in crontab file, use 'crontab –l' to list command, and start it from the home directory
- Check if lock files exist in the SEISNET work directory, SEISNET option 13

- Redirect the output from the SEISNET cron job into a file, and check for errors
- Try to setup some other cronjob to test that cron is active, e.g. 15 * * * * /bin/date > test.log
- Use option to check Seisnet parameter file
- Check user's email inbox, which may contain response from cron
- If waveform data is downloaded, but request remain in S-file, probably S-file name has been changed by the user
- Check that event detection directory do not have too many files (> 2000)

5.4 Parallel operation

Several SEISNET processes , each with their own parameter file, can be operated at the same time , which makes it possible to divide a network into sub-networks. This might be essential to speed up the data transfer.

As an alternative, it is possible to divide the nodes into groups. This is done by defining the TRANSFERSLOT for every node. With the option '-ts x' it is then possible to start only one group of stations, the ones with TRANSFERSLOT x. This way it is also possible to combine stations that participate in the network detection and stations for which continuous data is transferred into a single parameter file. Also it is possible to start data transfer for different slots (group of stations) more or less frequent. If no slot number is given, all stations in parameter are processed.

It is for example possible to run data transfer on several modems in parallel. Different processes can write to the same log files.

Example, network with 3 modems. The network has one parameter file with 3 slots dividing the network into 3 groups (each group one network):

- Run one crobtab process using no slot to get triggers from all stations, and do event detection
- Run 3 crontab processes with 3 different slots to get waveform files

The instant waveform data transfer supports parallel transfer. This option is not fully tested and still in an experimental stage. The principle is rather simple, the parent process is split for every slot that is defined in the parameter file. For every station the transfer slot is defined.

5.5 Examples of station setup

5.5.1 Continuous data

By continuous data here we mean the complete data stream from a seismic node. As explained earlier, continuous data could be available as either a system of discrete ring buffer files (examples: QNX Seislog, FTP server) or as segments taken from a continuous stream (examples: IRIS, SDAS, NAQS). The continuous data by SEISNET can be stored in either one directory or can be inserted into a SEISAN continuous data base. Note that this data base can then be used as a new node for another SEISNET process.

In SEISNET there are no special parameters to deal with continuous data since existing parameters can be used to set it up.

Example 1: FTP type station, which in this case is an Earthworm system that is writing out

continuous data in Seisan format

- Set up node as ftp server
- Set WAVEFORM to YES to collect waveform data
- Set EVENTDETECTION to NO, to avoid that node is part of network event detection, and at the same time to force waveforms to be placed into station waveform database
- Compression of the SEISAN files after transfer is activated (COMPRESSWAV)
- Ring buffer waveform files will be treated as events and the S-files for the SEISAN continuous data base are created

```
set STATION(i)                EW
set STATIONNAME(i)            Earthworm
set DATABASE(i)               EW
set ACTIVE(i)                 YES
set NUMBER(i)                 xxx
set LOGIN(i)                  earthworm
set PASSWORD(i)               xxx
set SYSTEMTYPE(i)             FTP
set LISTCOMMAND(i)            "ls"
set FILENAMEPATTERN(i)        ????-??-??-????-??S.?????_???
set FILENAMEYEAR(i)           "  1   4"
set FILENAMEMONTH(i)          "  6   7"
set FILENAMEDAY(i)            "  9  10"
set FILENAMEHOUR(i)           " 12  13"
set FILENAMEMIN(i)            " 14  15"
set FILENAMESEC(i)            " 17  18"
set CONVERSIONPROGRAM(i)      NONE
set CONNECTION(i)             INTERNET
set TRANSFER(i)               BIN
set WAVEFORM(i)               YES
set WAVEFORMDIR(i)            /data/archive
set WAVEFORMBASE(i)           /users/seismo/WAV/EW___
set COMPRESSWAV(i)            YES
set TRANSFERSLOT(i)           1
set EVENTDETECTION(i)         NO
set STOPSECBEFORE(i)          2000
```

Example 2: QNX type station that is set for continuous data transfer, note the SYSTEMTYPE is QNXSEISLOG and the SYSTEMSUBTYPE is LS, which means the data will be transferred as if it was a FTP type station. In this ways the ring buffer waveform files will be treated as events and the S-files for the SEISAN continuous data base are created:

```
set STATION(i)                QNX
set STATIONNAME(i)            QNX
set DATABASE(i)               QNX
set ACTIVE(i)                 YES
set NUMBER(i)                 xxx.xxx.xxx.xxx
set LOGIN(i)                  xxx
set PASSWORD(i)               xxx
set SYSTEMTYPE(i)             QNXSEISLOG
set SYSTEMSUBTYPE(i)          LS
set TRANSFER(i)               BIN
set LISTCOMMAND(i)            "ls"
set CONNECTION(i)             INTERNET
set FILENAMEPATTERN(i)        R????_????_??_??_????_??T.LEQ_14_C
set FILENAMEYEAR(i)           "  7  10"
set FILENAMEMONTH(i)          " 12  13"
set FILENAMEDAY(i)            " 15  16"
set FILENAMEHOUR(i)           " 18  19"
set FILENAMEMIN(i)            " 20  21"
set FILENAMESEC(i)            " 23  24"
set CONVERSIONPROGRAM(i)      qnxsei
set PROMPT(i)                 QNX>
```

```
set RESTART(i)                NO
set WAVEFORMDIR(i)            /home/rngbuf
set WAVEFORMBASE(i)           /users/seismo/WAV/QNX__
set WAVEFORM(i)               YES
set EVENTDETECTION(i)         NO
set TRANSFERSLOT(i)           2
set COMPRESSEDTRANSFER(i)     YES
set COMPRESSWAV(i)            YES
set STOPSECBEFORE(i)          3600
```

Example 3: IRIS type station for which continuous data is extracted by specifying time windows for data extraction

- Set extract intervals to cover the 24 hours, in exmple this is done by setting 24 1-hour intervals
- WAVEFORM and EVENTDETECTION are set as explained in Example 1
- The stream for extraction is selected with the parameter EXTRACTCOMPONENT, in this case 10-BHZ, which means that all 10-BH? data will be taken, based on the first COMPONENTS definition

```
set STATION(1)                KONO
set STATIONNAME(1)            Kongsberg
set DATABASE(1)               KONO
set ACTIVE(1)                 NO
set NUMBER(1)                 129.177.55.xx
set LOGIN(1)                  xxx
set PASSWORD(1)               yyy
set SYSTEMTYPE(1)             IRISB
set COMPONENTS(1)             "10-BHZ:10-BH?                          60     600 "
set COMPONENTS(1)             "00-LHZ:00-LH?                          1800  9000 "
set CONNECTION(1)             INTERNET
set TRANSFER(1)               FTP
set WAVEFORM(1)               YES
set EVENTDETECTION(1)         YES
set EXTRACTTIME(1)            "0000 0100 0200 0300 0400 0500 0600 0700 0800 0900
1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300"
set EXTRACTDURATION(1)        "3600 3600 3600 3600 3600 3600 3600 3600 3600 3600
3600 3600 3600 3600 3600 3600 3600 3600 3600 3600 3600 3600 3600 3600"
set EXTRACTCOMPONENT(1)       "10-BHZ"
set EXTRACTDATABASE(1)        "KONOC"
```

In the examples the corresponding station data bases contain the waveform file and plotting can be done directly from eev or mulplt (option cont). The number of S-files in station data bases will equal the number of waveform files available.

5.5.2 Noise extract (continuous)

A QNX type station that is set for noise extracts of 60 seconds at 5 AM would be specified as follows:

```
set STATION(i)                QNX
set STATIONNAME(i)            QNX
set DATABASE(i)               QNX
set ACTIVE(i)                 YES
set NUMBER(i)                 xxx.xxx.xxx.xxx
set LOGIN(i)                  xxx
set PASSWORD(i)               xxx
set SYSTEMTYPE(i)             QNXSEISLOG
set SYSTEMSUBTYPE(i)          LGS
set CONNECTION(i)             INTERNET
set PROMPT(i)                 QNX>
set RESTART(i)                NO
set WAVEFORMDIR(i)            /home/events
set WAVEFORM(i)               YES
set EVENTDETECTION(i)         YES
set DOWNLOAD_IDXLOG(i)        NO
set TRANSFERSLOT(1)           1
set COMPRESSEDTRANSFER(i)     YES
set COMPRESS(i)               NO
set EXTRACTTIME(i)            "0500"
set EXTRACTDURATION(i)        "60"
set EXTRACTDATABASE(i)        NOISE
```

It is possible to use a similar setup to extract continuous data, by giving continuous start times:

```
set EXTRACTTIME(i)            "0000 0100 0200 …"
set EXTRACTDURATION(i)        "3600 3600 3600 …"
```

5.5.3 Extract additional data for QUAKE events

To extract data from stations 1, 2, 3 and 4 (in the same parameter file) to the central data base for all locations given by the PDE with magnitude above 5.6:

```
set STATION(i)                PDE
set STATIONNAME(i)            PDE
set DATABASE(i)               PDE
set ACTIVE(i)                 YES
set NUMBER(i)                 ghtftp.cr.usgs.gov
set SYSTEMTYPE(i)             QUAKE
set SYSTEMSUBTYPE(i)          FTP
set REGION(i)                 "-90,90,-180,180,5.6"     ; # coordinates or NO
set WAVEFORM(i)               NO
set TRANSFERSLOT(i)           1
set EXTRACTSTATION(i)         "1 2 3 4"
set EXTRACTDURATION(i)        "600"
```

6. Logging

The logging of the data transfer is an important part of SEISNET, since it allows the user to follow the performance of the programs. SEISNET keeps two log files. The first is rather detailed and gives info about the complete process. The second is a summary, which is created based on the detailed log file every time SEISNET is closed. Both log files are kept on a daily basis in yearly and monthly directories to a directory specified by LOGFILEDIR. The filenames contain the date. The order of stations to be listed in the summary log file can be defined with the parameter LOGFILE_STATIONORDER. Both log files are easy to read and should not require much explanation. The times given in the detailed log file are in GMT. If all log information go to the same directory for several processes using different parameter files, then LOGFILE_STATIONORDER should be the same in all parameter files.

Example of detailed log file (file name $LOGFILEDIR/2002/10):

```
…
2002/10/01 00:59:01 ABCD transfer parametric data
2002/10/01 00:59:02 ABCD connected
2002/10/01 00:59:04 ABCD number of detections 3
2002/10/01 00:59:12 ABCD connected
2002/10/01 00:59:27 ABCD file transferred 2002-09-30-2329-32S.EDI___003
2002/10/01 00:59:41 ABCD file transferred 2002-09-30-2349-32S.EDI___003
2002/10/01 00:59:55 ABCD file transferred 2002-10-01-0009-32S.EDI___003
2002/10/01 00:59:55 ABCD number of waveforms to transfer 3
2002/10/01 00:59:55 ABCD number of waveforms transferred 3
…
```

Example of summary log file :

```
Seisnet summary log for Wed Oct  2 2002
************************************************************
Station/Network:       ABC
System:                QNXSEISLOG
Connections:           3
Last connection:       2003/12/02 08:10:49
Disk usage:            78%
Detections:            21
Extracts:              0
Waveforms transferred: 2
Waveforms failed:      19
Last detection:        2003/12/02 00:25:16
Last waveform:         2003_12_01_1006_54T.KMY_03_1
Time difference:       1.0 (central time - station time)
Station uptime:        100.0
GPS uptime:            100.0
------------------------------------------------------------
Station/Network:       DEF
Connections:           6
Disk usage:            29%
Detections:            0
Extracts:              1
…
```

Single connection logfiles

Optional it is possible to create a log file for every parametric or waveform data transfer. This option can be activated by setting the variable SINGLE_LOG variable in the EXP/seisnet.par file to ‘YES’. Errors will be traced in this log file. Filenames of these log files show the start time of the connection, type of transfer (PAR or WAV) and the station name, e.g. ‘KONO.PAR.19970925100531’. These files will be written to the work directory, which is defined in the parameter file.

7. Further processing using SEISAN

The SEISNET software will provide the user with automatically downloaded data and preliminary locations. The event data are stored in the SEISAN database structure, while the waveform data are kept in the SEISNET working directory. The SEISAN programs EEV and MULPLT have been modified to make the processing of collected data more comfortable. In principle the complete processing can be done with these two programs. This section gives some recommendations on how the data can be manually checked and processed. It is assumed that waveform data are only transferred for network events, which can be all triggers from the stations, if the minimum number of triggers is set to one. A basic understanding of SEISAN is needed to follow the procedure.

The basic steps are:

1. Go to the SEISNET work directory, since all new waveform data is there

2. Use EEV on the central database

3. Find event of interest, either by date or latest event that has not been processed, which can be found with the command 'ss' in EEV. New events (action is SPL or NEW) are marked with 'N' when shown in EEV.

4. Check if event should have been merged with event before or after. They can be merged with the 'a' command in EEV.

5. Plot event

   The S-file can point to several waveform files, since these are not automatically merged. The waveform data can be plotted with command 'p' or 'po', when using 'po' the default channels will be plotted with default filter, this is a fast way of plotting. Several files can be plotted at the same time, they will be temporarily merged. Pressing 'f' in multi trace mode, the user will jump to the next event in the database in both cases ('p' and 'po').

   - false event:
     - delete S-file from MULPLT or EEV
   - all detections belong to the same event:
     - merge waveform files (MULPLT)
     - register (EEV or MULPLT), the S-file is cleaned up and the waveform files are transferred to the WAV directory
     - locate
   - some detections belong to the same event:
     - delete the traces that do not belong to this event using MULPLT (only names in S-file)
     - continue as above
   - two events in one S-file:
     - duplicate event using the 'dup' command
     - continue as above

8. Programming details of SEISNET

The purpose of this section is to give some insight to the SEISNET source code, which may give some help on how detect problems and on how to write your own modules. It is assumed that the reader is familiar with Expect and Fortran.

The source code is distributed over three directories:

EXP: the expect code
PRO: the Fortran program source code
LIB: Fortran subroutines that are combined into the SEISNET library and used by the FORTRAN programs

The Expect code (EXP/)

The user interface to SEISNET as well as the control over all SEISNET processes is given by the seisnet.exp script. When running seisnet, seisnet.exp is interpreted by Expect. However, seisnet.exp does not contain all the Seisnet Expect code, instead the Expect code is divided into several files. General procedures are given in seisnet_lib.exp, and node type specific procedures are given in the files seisnet_*nodetype*.exp. For example seisnet_qnxseislog.exp contains all the procedures related to the QNXSEISLOG node type. The additional Expect files are sourced from seisnet.exp. The Expect source files contain lists of procedures and explain what the procedures do.

The Expect code reads the network parameters and based on the selected task controls the data transfer by running other programs (e.g., telnet and ftp). Also, there is a number of Fortran programs that are part of SEISNET. Command line arguments are used to pass information from the Expect script into these Fortran programs. Afterwards standard input/output is used for communication between the Expect script and the programs.

The Fortran code (LIB/ and PRO/)

The LIB directory contains node type specific subroutines or subroutines that are of general use. Node type specific files are named like *qnxseislog*_sub.for. All files contain a list of subroutines with a short explanation of what they do.

The PRO directory contains the programs used by SEISNET. The program FSEISNET is used to start various jobs, where the job is specified through command line arguments.

Adding new node types

New node types can be added quite easily. Before you start, it is probably best to study some of the existing types. It may be best to first define the parameters needed for the new type, the STATIONTYPE will give a name that is used within Seisnet to start node type specific tasks. The routines for transfer of parametric and waveform data will call the system dependant routines using $SYSTEMTYPE(i)_par and $SYSTEMTYPE(i)_wav respectively. This is probably the only convention that needs to be followed. Generally needed are login procedures and procedures for data transfer. The conversion of parametric data to Seisan may be best done in Fortran, but could also be done in C. In case Seisan does not have the waveform conversion program needed, this also may have to be added.

9. Acknowledgements

We wish to thank Luis Alberto Arriola, who was involved in the programming of SEISNET during the first months. Development of this software is part of the project in disaster prevention between all Central American countries, which was initiated and organised through CEPREDENAC (Centro de Coordinacion para la Prevencion de Desastres Naturales en América Centro). Many fruitful comments over the years were given by Anne Lise Kjærgaard. Suggestions by Rajesh Prakash and others from IMD, India have helped to improve the software. Comments by Peter Voss from KMS, Copenhagen, are highly appreciated.

The development of the routines for data transfer from the Nanometrics NAQS was supported by FUNVISIS, Caracas, Venezuela.

David Scott from BGS Edinburgh has written parts of the SDAS routines.

10. Who uses SEISNET

The following list gives a list of known institutions that use SEISNET:

- British Geological Survey, UK
- Central American Seismic Center, Costa Rica
- FUNVISIS, Venezuela
- India Meteorological Department, India
- INETER, Nicaragua
- INSIVUMEH, Guatemala
- Kort & Matrikelstyrelsen, Denmark
- University of Bergen, Norway
- University of Chile, Chile
- University of Granada, Spain

(Please inform the authors if you want to be added/removed to/from the list)

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