SEISNET

Seismic Network Automation Software

Version 2.0.6

By

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February 2001

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1. Introduction

A common problem in the operation of seismic networks is the use of various data acquisition and communication systems. The goal of the SEISNET seismic network automation software is to combine various types of seismic data sources into one virtual seismic network (Ottemöller and Havskov, 1999). The development of SEISNET started in the beginning of 1997. 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

SEISNET is mainly written in the script language Expect (Libes, 1995), which is available for most Unix systems. Expect is a script language that can be 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 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 available for the SunOS operating system. SEISNET can only be used in connection with the SEISAN, seismic analysis software, since SEISAN programs and the database structure are used by SEISNET. SEISNET serves as link between seismic stations of different type and the SEISAN analysis software.

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 sense. To indicate the difference, it will be called a virtual seismic network (VSN) in this manual.

A seismic node and the virtual seismic network will be defined as follows:

- 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. It can be seen that 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
Quanterra	X	X	X	X	X
SEISLOG	X	X	X	X	X
FTP server	X		X	X	
AutoDRM	X				X
Finger quake (e.g. NEIS)	X		X		
SEISAN database	X		X	X	

1.1 Latest Changes

Version 2.0.2, date 1999-10-04

- Parallel Instant waveform data transfer
- Flexible Kermit Login files for IRIS stations
- New argument –ws to specify suffix of waveform request files
- independence of interactive and background waveform transfer now possible

Version 2.0.5, date 2000-04-06

- Support extract from QNXSEISLOG stations
- Compressed transfer for QNXSEISLOG stations using gzip/gunzip
- New QNXSEISLOG subtype systems, parameter data can be transferred from QNXSEISLOG stations as for FTP server stations, particularly useful for transfer of ringbuffer files
- Support for several parameter sets for QNXSEISLOG stations
- Alarm function in case of events
- In the parameter file use QNXSEISLOG instead of QNX
- New simple detection program findp

Version 2.0.6, date 2001-02-06

- Support for ncftp for transfer from QNXSEISLOG systems
- Move waveform files to Seisan waveform database structure, QNXSEISLOG
- use active command on QNXSEISLOG to check if system is running
- QNXSEISLOG retstart changed into reboot, in case of stop
- Support for ftp transfer from Quanterra/IRIS stations
- Set time interval with ACTIVE parameter
- Rename ringbuffer filenames from Windows Seislog system, ftp server transfer option

This version of Seisnet is tested with Seisan Version 7.1.

1.2 Information about SEISNET online

Homepage

Information about SEISNET can be found on the SEISNET homepage:

http://www.ifjf.uib.no/seismo/software/seisnet.html (or 129.177.55.3 instead of www.ifjf.uib.no)

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@ifjf.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

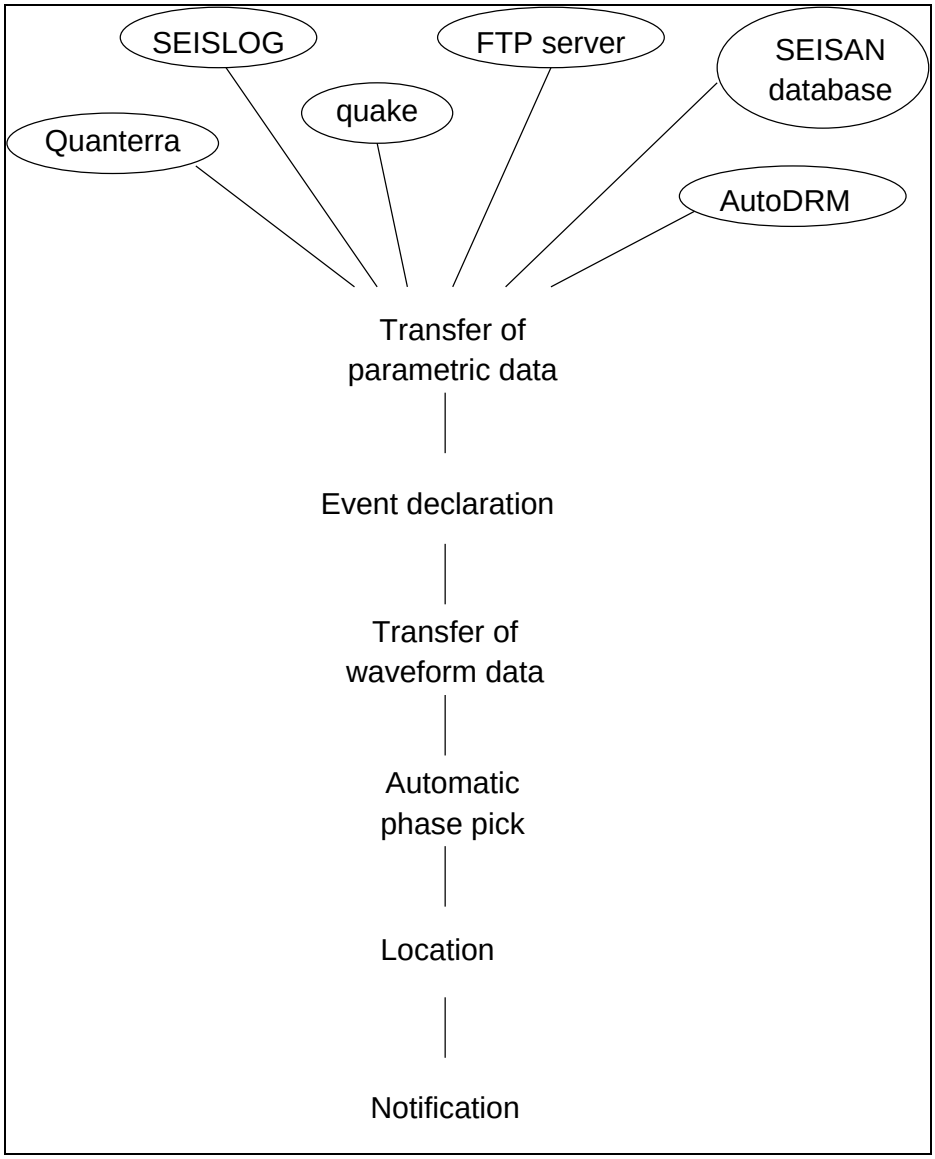
help

To *majordomo@ifjf.uib.no*

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.

Figure 1. Concept of automatic data transfer and processing.



Data transfer and processing can be done from present to several months back in time.

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.

Network Event Detection

SEISNET reads parametric information from the single seismic node databases and sorts these in time. An event is detected if within a given time interval there are triggers on at least a given number of stations, the detections are merged into one event. Using a minimum number of one trigger to detect events, triggers from all stations will be detected as events. Events from the node databases will be flagged if they are merged with detections from other nodes. Detected events are put into a central database. The event detection will be the most intelligent part of the system, but is not finished yet. The current version only uses time as criteria for event detection. In the future, additional parameters will be used for event detection.

Transfer of Waveform Data

In this process, waveform data will be transferred from the seismic nodes. First, the central database is scanned and the information for data transfer is extracted. Then the system transfers the requested data and converts to SEISAN format immediately after transfer. After successful transfer, the corresponding event files will be updated in the central database, not to transfer the data again. Merging of waveform files from different stations for one event is not done automatically.

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 every minute. 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 center soon after it has been detected on one of the master stations.

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 is 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 7.1 (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.

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 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 SEISNET top directory, preferably not the same as the SEISAN top directory.

First the file is uncompressed:

```
uncompress seisnet.sun.tar.Z
```

Then data are restored from tar file:

```
tar xvf seisnet.sun.tar
```

Now the SEISNET directories and files are extracted.

List of directories and files:

README	- SEISNET readme file
seisnet.pdf	- manual in PDF format
EXP/seisnet.exp	- SEISNET Expect script
EXP/seisnet.par_org	- SEISNET parameter file, example, will not overwrite existing seisnet.par
EXP/seisnet_cron.par_org	- SEISNET parameter file for non interactive use, example, will not overwrite existing seisnet_cron.par
EXP/STAT1.KER	- Example of Kermit Login file for IRIS Internet station
EXP/STAT2.KER	- Example of Kermit Login file for IRIS Modem station
PRO/Makefile	- Makefile for PRO directory
PRO/autopro.for	- automatic processing program
PRO/autopro	- executable of autopro.for
PRO/event.for	- event detection program
PRO/event	- executable of event.for
PRO/fseisnet.for	- utility program used by seisnet.exp
PRO/fseisnet	- executable of fseisnet.for
PRO/seven.for	- simplified eev to select events from database
PRO/seven	- executable of seven.for
PRO/splitmailfile.for	- program to split the mail into files

PRO/splitmailfile	- executable of splitmailfile.for
PRO/wave.for	- waveform request program
PRO/wave	- executable of wave.for
LIB/Makefile	- Makefile for LIB directory
LIB/autodrml.for	- library file
LIB/hypparm.inc	- include file
LIB/minttl.for	- library file
LIB/seisnetl.for	- library file
COM/.SEISNET_org	- shell script for definition of global SEISNET variables and path definitions, needs to be sourced, existing .SEISNET will not be overwritten when the new version is installed

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. It is recommended to source the COM/.SEISNET file from the .cshrc 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 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 comment, the line MUST be written as given above

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.

```
setenv SEISNET_TOP /net/seismo/seismo
alias seisnet       '$SEISNET_TOP/EXP/seisnet.exp -pf $SEISNET_TOP/EXP/seisnet.par'
alias sn            'cd $SEISNET_TOP/EXP'
```

The Parameter File (EXP/seisnet.par)

See EXP/seisnet.par_org for 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. This is done out of two reasons: 1) several parameter files can be used in parallel without changing the environmental settings and 2) when SEISNET is running as a cron job, the environmental settings are not done.

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.

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".

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

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
NUMBEROFSTATIONS	- number of stations in parameter file
NUMBEROFSLOTS	- number of slots for parallel transfer, the idea is to define slots for groups of stations, on one slot data is from a number of stations is transferred in series, while several slots are running in parallel, only works with instant waveform transfer,
INSTITUTENAME	- name of institute
HOMEDIRECTORY	- name of user's home directory, useful, since then this can be used as variable inside the parameter files, see example
WORKDIRECTORY	- directory that will be used when SEISNET is running, waveform files and log files will be put into this

	directory
STATIONPARAMETERSUN	- this directory will have station subdirectories used for changing of parameter files on SEISLOG stations, remember to create these directories
STATIONMONITOR	- directory for station monitor files, which give overview of last transfer
CRONPARAMETERFILE	- name of additional parameter file, which will be used if SEISNET is variable CRONJOB is set to 'YES', which is required to run SEISNET as cronjob
FTPPROGRAM	- name of ftp program (ftp or ncftp), ncftp can be used only with QNXSEISLOG or FTP station type
SEISNETEDITOR	- name of editor that will be used by SEISNET
PSPRINT	- name of printing command for ASCII files
TIPMODEM	- name of modem used by tip program, see /etc/remote file, and tip man pages
KERMITLINE	- device name of modem line used for Kermit, see /etc/remote file, and kermit man pages
KERMITMODEM	- type of modem used for Kermit
CENTRALDATABASE	- events declared by the EVENT program will be put into the SEISAN database defined by this parameter
LOGDATABASE	- name of database that is used for daily log files
LOG_SUFFIX	- suffix for daily logfile, which is needed, if more than one SEISNET are used in the same directory structure
OPERATOR	- operator code, maximum three characters, used by split program
PRINTLOG	- if daily summary logfiles should be printed automatically, this parameter has to be set to 'YES'
REPEATSTATION	- definition of how often in case of errors data transfer will be done for a station, used by multi station event detection and waveform data transfer
DATABACK	- gives the maximum number of days before current date, only detections within these days will be transferred
OS	- operating system, SUNOS, SOLARIS or LINUX
SINGLE_LOG	- specifies, if log is created for every single connection

SEISNET_EMAIL	- SEISNET user's email address
MAILPROGRAM	- name of command line based email program (Mail, xmail, …)

Auto Processing Parameters

PROCESSINGDAYS	- number of days before current date, used by the EVENT program, only data within these days will be used for event detection
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, as network trigger
AUTOLOCATE	- set to YES, if SEISNET should do automatic location
AUTOPICK	- name of program to use for autopick, FINDP or AUTOPIC
ALERT_EMAIL_MIN_MAG	- minimum magnitude required to send out an alert
ALERT_EMAIL_ADDRESS	- email address to use when sending out the alert message, this may be an email list server address, several adresses can be separated by comma like abc@test.com,efg@some.org

Parameters for Waveform Transfer

WAVEFORMOPTION	- defines the option for making lists of waveform requests used by the WAVE program. The options are: 0 - no waveform data transfer 1 - get waveform data from all stations, that are set to WAVEFORM(i) = YES 2 - get waveform data only for events in the central database and stations, that are set to WAVEFORM(i) = YES
WAVEBACK	- requests for waveform data are only made for this number of days before the current date

AutoDRM Parameters

MAILFILE	- name of file with incoming email
AUTODRMLOCK	- name of lock-file to be used with AutoDRM options
AUTODRMWORK	- work directory for AutoDRM options
AUTODRMMAIL	- name of file to which incoming mail will be saved
BACKUPMAILCOMMAND	- command to make a backup of the incoming mail, Since it will be deleted by the SAVEMAILCOMMAND
SAVEMAILCOMMAND	- command to save mail to file; AUTODRMMAIL can be used as variable for the file, the mail is saved to
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

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)

Station Parameters for QNX-SEISLOG Station

(i = station index, between 1 and NUMBEROFSTATIONS)

STATION(i)	- station code, maximum 5 characters
STATIONNAME(i)	- station name
DATABASE(i)	- name of SEISAN database for this station, 5 characters
ACTIVE(i)	- set to 'YES', if station is used for event detection transfer for many stations
NUMBER(i)	- station number, Internet IP address or phone number
LOGIN(i)	- login
PASSWORD(i)	- password
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 transfer of ringbuffer files, 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

CONNECTION(i) - INTERNET or MODEM

BAUDRATE(i) - only used if CONNECTION(i) is 'MODEM', gives the the transfer rate for modem connection in baud, can be set to 'AUTO' for automatic setting

TRANSFER(i) - ASCII or BINARY for mode of transfer, only for modem station

PROMPT(i) - Unix prompt

RESTART(i) - set to 'YES', if station should be restarted in case it is not running, used in connection with detection parameter transfer

WAVEFORMDIR(i) - directory of waveform files on the station

WAVEFORM(i) - set to 'YES' if waveform data should be transferred, used by the WAVE program and the routine for waveform transfer for many stations

EVENTDETECTION(i) - set to 'YES' if station event database should be used for event detection by the EVENT program

DOWNLOAD_IDXLOG(i) - if the 'idx_log' file should be downloaded and processed

TRANSFERSLOT(i) - in the instant waveform transfer this parameter defines Which slot should be used for the respective station, I <= NUMBEROFSLOTS

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 stations is different from IRISA!

(i = station index, between 1 and NUMBEROFSTATIONS)

STATION(i) - station code, maximum 5 characters

STATIONNAME(i) - station name

DATABASE(i) - name of SEISAN station database, 5 characters

ACTIVE(i) - set to 'YES', if station is used for event detection transfer for many stations

NUMBER(i) - number of station, Internet IP address or phone number

LOGIN(i) - login

PASSWORD(i) - password

SYSTEMTYPE(i) - IRISA or IRISB, see above

CONNECTION(i) - INTERNET 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

KERMITTYPE(I) - WAIT or NOWAIT, try which one works for your stations, Normally NOWAIT should work

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

BAUDRATE(i) - only used if CONNECTION(i) is 'MODEM', gives the transfer rate for modem connection in baud, can be set to 'AUTO' for automatic setting

COMPONENTS(i) - gives information about components used. Any Number 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 this line (only 1 line should be used, ASCII or BINARY):
12345678901234567890123456789012345678901234567890123456789012345678901234567890
set COMPONENTS(4)             "BHZ   :BHZ    BHN    BHE            60    6000 " (ASCII)
set COMPONENTS(7)             "BHZ   :BH?                          60    300  " (FTP, BINARY)
```

WAVEFORM(i) - set to 'YES' if waveform data should be transferred, used by the WAVE program and the routine for waveform transfer for many stations

EVENTDETECTION(i) - set to 'YES' if station event database should be Used for event detection by the EVENT program

TRANSFERSLOT(i) - in the instant waveform transfer this parameter defines Which slot should be used for the respective station, I <= NUMBEROFSLOTS

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. Both ASCII and Kermit Binary data transfer are supported. There must be one STAT.KER file in the seisnet/EXP directory for each station using kermit

Parameters for QUAKE

(i = station index, between 1 and NUMBEROFSTATIONS)

STATION(i) - station code, maximum 5 characters

STATIONNAME(i) - station name

DATABASE(i) - name of SEISAN station database, 5 characters

ACTIVE(i) - set to 'YES', if station is used for event detection transfer for many stations

NUMBER(i) - address used for finger, for example: quake@gldfs.cr.usgs.goc

SYSTEMTYPE(i) - QUAKE

REGION(i) - this parameter can be used to put events from a Given region into the central database directly, the format is "min_lat,max_lat,min_long,max_long, max_mag" or NO in case this option is not wanted, see example in Figure 4

```
       Example of this line:
12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
set REGION(6)                  "-20,20,60,90,6.0"     ; # coordinates or NO
```

WAVEFORM(i) - should always be NO

Parameters for Stations that are FTP Servers
(i = station index, between 1 and NUMBEROFSTATIONS)

STATION(i) - station code, maximum 5 characters

STATIONNAME(i) - station name

DATABASE(i) - name of SEISAN station database, 5 characters

ACTIVE(i) - set to 'YES', if station is used for event detection transfer for many stations

NUMBER(i) - IP address of station

CONNECTION(i) - INTERNET

TRANSFER(i) - BIN or ASCII

LOGIN(i) - login

PASSWORD(i) - password

SYSTEMTYPE(i) - FTP

WAVEFORM(i) - set to 'YES' if waveform data should be transferred, used by the WAVE program and the routine for waveform transfer for many stations

WAVEFORMDIR(i) - directory name with waveform files

EVENTDETECTION(i) - set to 'YES' if station event database should be Used for event detection by the EVENT program

LISTCOMMAND(i) - command used for directory listing on the FTP Server

FILENAMEPATTERN(i) - pattern of waveform files, '?' is used as wildcard

CONVERSIONPROGRAM(i) - name of conversion program to be used for data from this FTP server. If data is not to be converted write NONE. If the ftp server is a Windows Seislog system type winseislog, only file name will be changed, conversion programs tested are: qnxsei

FILENAMEYEAR, FILENAMEMONTH, FILENAMEDAY, FILENAMEHOUR, FILENAMEMIN, FILENAMESEC - definition of data and time in waveform file name
col 32 – 34 : index of character from
col 36 – 38 : index of character to

Example:

```
1234567890123456789012345678901234567890
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"
```

TRANSFERSLOT(i) - in the instant waveform transfer this parameter defines Which slot should be used for the respective station, I <= NUMBEROFSLOTS

STOPSECBEFORE(i) - only transfer detection information up to number of seconds before now, useful when transferring continuous data

Parameters for AutoDRM Nodes

(i = station index, between 1 and NUMBEROFSTATIONS)

STATION(i) - station code, maximum 5 characters

STATIONNAME(i) - station name

DATABASE(i) - name of SEISAN station database, 5 characters

ACTIVE(i) - set to 'YES', if station is used for event detection transfer for many stations

WAVEFORM(i) - set to 'YES' if waveform data should be transferred, used by the WAVE program and the routine for waveform transfer for many stations

EVENTDETECTION(i) - set to 'YES' if station event database should be used for event detection by the EVENT program

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 line:

```
12345678901234567890123456789012345678901234567890123456789012345678901234567890
set COMPONENTS(8)              "*                                      60    500  "
```

SYSTEMTYPE(i) - AUTODRM

AUTODRMADDRESS(i) - the AutoDRM email address

TRANSFERSLOT(i) - in the instant waveform transfer this parameter defines Which slot should be used for the respective station, I <= NUMBEROFSLOTS

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
#

puts "setting parameters for autostart ...\r"

set env(TERM) xterm
set env(USER) online

#
# PATH DEFINITION
#

setenv(PATH)
"/net/seismo1/s2000/seismo/PRO:/net/seismo1/seisnet/seisnet_new/PRO:.:/bin:/local/bin:/
net/seismo1/s2000/seismo/COM:/prog:/usr/bin/X11:/ifjf/openwin/bin:/local/lib:/usr/bin:/
local/X11R5/bin:/usr/ucb:/usr/etc:/usr/5bin:/usr/lang:/usr/local/bin:/net/seismo1/seisn
et:/net/seismo1/seisnet/seisnet_new/seisnet"

puts "$env(PATH) \r"


set env(LD_LIBRARY_PATH) "/usr/lib:/seismo/lib"
#
#   SEISAN SETTINGS
#
set env(PRINTER) ALK
set env(SEISAN_TOP) /net/seismo1/seisnet/seisnet_new
set env(AGENCY) NET
set env(DEF_BASE) NET
```

4. SEISNET Functionality

4.1 Seismic Nodes in SEISNET

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 ringbuffer 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.

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. 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.

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 setup for this type of stations is done within the parameter file, which means no software change is required.

AutoDRM

AutoDRM is a system for seismic data retrieval from seismic 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.

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@...’. 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 data base 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
```

4.2 Command Menu

For interactive use, the software is started with the command '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 3 5' will start parametric transfer, event detection and waveform transfer.

The menu looks like this:

```
 SEISNET     Version 2.0 --- name

( 1) Get parametric data from all nodes
( 2) Get parametric data from single node(s)
( 3) Network event detection
( 4) Start automatic processing
( 5) Transfer waveform data for all nodes
( 6) Transfer waveform data for single node(s)
( 7) Instantaneous waveform data transfer for selected event
( 8) Get continuous waveform data submenu
( 9) Get detections, event detection and waveform transfer
(10) Login to station
(11) QNX submenu
(12) AUTODRM submenu
(13) SEISNET parameter file submenu
(14) eev (last day)
(15) Station monitor

( q) Quit

choice ?
```

Description of the menu options

(1) Get parametric data from all nodes

The function of this option is to transfer parametric data from seismic nodes that are specified in the parameter file. Nodes used within this process are defined by the parameter 'ACTIVE', which has to be set to 'YES'. 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.

The parametric data, depending on the station type, is then 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 will later be used for waveform data transfer. The S-files are put into a SEISAN station database. There has to be one database per station.

Examples of S-files generated by parameter transfer:

```
  97  915 1354 13.1 D                      UPI  1                            1
ACTION:SPL 97-09-30 16:32    on                            00970915135413     I
NET WAV EVE UPIG IRI BLZ     97 258=09/15 13:53:13.1  STA301632 REQUEST       3
NET WAV EVE UPIG IRI BLN     97 258=09/15 13:53:13.1  STA301632 REQUEST       3
NET WAV EVE UPIG IRI BLE     97 258=09/15 13:53:13.1  STA301632 REQUEST       3
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7
UPIG BZ E        1354 13.10                              3

1997  915 1545 30   L                      UNA  1                            1
ACTION:SPL 97-09-30 16:22    on                            19970915154530     I
NET WAV EVE UNA  QNX 9709_15_1544_29T.UNA_03_1        STA301622 REQUEST       3
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7
UNA  SZ  P       1545 30.42  313
```

Different combinations of station and connection type are supported (Table 1). 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.

Table 1. Combination of node and connection types for parameter collection.

Station type	Connection type
SEISLOG - QNX	Internet
SEISLOG - QNX	Modem
IRIS / GSN	Internet
IRIS / GSN	Modem
Quake	Internet

For SEISLOG stations, after login to the station, it is checked if the station is running using the MON program. If the station is not running and the 'RESTART' parameter for this station is set to 'YES', the station is restarted, but no parameters are transferred. In addition, the station CPU time is compared to the time in the center and the disk space is checked. The station and clock uptime for the previous day are 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 can be used to produce monthly statistics.

(2) Get parametric data from single node(s)

In this option, the same as in 'Get detections for all stations' is done, but only for a single station that is selected from a list of stations. The only difference is that in case of an error there is no retry.

(3) Network Event detection

The EVENT program is started to read detection information from the single databases and the central database. This list of detections 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.

(4) Start Automatic Processing

This option starts the automatic processing, which is the automatic phase identification using AUTOPIC and the epicenter location using HYPOCENTER.

(5) Transfer requested waveform data for all stations

This function transfers waveform data from all seismic stations for which the 'WAVEFORM' parameter is set to 'YES' in the parameter file.

First the WAVE program is started to make lists of waveform data requests. Depending on the option for waveform data transfer, which is given in the parameter file, the request list is made for the central database or all stations with 'WAVEFORM' set to 'YES'. If the request is made for the central database, only waveform data for declared events is done, which in principle could be all single station detections. The WAVE program writes one file of waveform data requests for each station, which then is used to transfer the data. Examples of waveform request are shown below:

IRIS / GSN:

if TRANSFER is FTP or BINARY:

```
BHZ   98/04/14 03:58:58     300 /net/seismo/seismo/REA/BER/98/04/14-0359-24D.S9804
BHN   98/04/14 03:58:58     300 /net/seismo/seismo/REA/BER/98/04/14-0359-24D.S9804
BHE   98/04/14 03:58:58     300 /net/seismo/seismo/REA/BER/98/04/14-0359-24D.S9804
LHZ   98/04/14 06:24:47    6000 /net/seismo/seismo/REA/BER/98/04/14-0654-47D.S9804
LHN   98/04/14 06:24:47    6000 /net/seismo/seismo/REA/BER/98/04/14-0654-47D.S9804
LHE   98/04/14 06:24:47    6000 /net/seismo/seismo/REA/BER/98/04/14-0654-47D.S9804
```

if TRANSFER is ASCII:

```
BHZ   98/04/10 17:02:34    6000 /net/seismo/online/REA/KON/98/04/10-1703-34D.S9804
BHN   98/04/10 17:02:34    6000 /net/seismo/online/REA/KON/98/04/10-1703-34D.S9804
BHE   98/04/10 17:02:34    6000 /net/seismo/online/REA/KON/98/04/10-1703-34D.S9804
LHZ   98/04/10 17:23:46    6000 /net/seismo/online/REA/KON/98/04/10-1753-46D.S9804
LHN   98/04/10 17:23:46    6000 /net/seismo/online/REA/KON/98/04/10-1753-46D.S9804
LHE   98/04/10 17:23:46    6000 /net/seismo/online/REA/KON/98/04/10-1753-46D.S9804
```

SEISLOG:

```
9709_30_0708_32T.HYA_03_1 /net/seismo/seismo/REA/HYA/97/09/30-0709-33L.S9709
9709_30_0724_07T.HYA_03_1 /net/seismo/seismo/REA/HYA/97/09/30-0725-08L.S9709
9709_30_0727_04T.HYA_03_1 /net/seismo/seismo/REA/HYA/97/09/30-0728-05L.S9709
9709_30_0805_34T.HYA_03_1 /net/seismo/seismo/REA/HYA/97/09/30-0806-35L.S9709
9709_30_0814_16T.HYA_03_1 /net/seismo/seismo/REA/HYA/97/09/30-0815-17L.S9709
9709_30_0819_57T.HYA_03_1 /net/seismo/seismo/REA/HYA/97/09/30-0820-58L.S9709
9709_30_0821_29T.HYA_03_1 /net/seismo/seismo/REA/HYA/97/09/30-0822-30L.S9709
```

Then the routine connects to the station. For QNX stations data are transferred from the events directory and for IRIS / GSN stations from the continuous buffer. The waveform request list file is then opened, every line in this file includes a request for waveform data and the name of the corresponding event detection S-file. Waveform data are transferred for all requests in the file and immediately converted to SEISAN format. In case of error free transfer and conversion, the event file is updated. In the request line, 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. This means that the waveform request file is created again, and already transferred data are not transferred again.

Example:

before update:

```
1997  915 1545 30   L                       UNA  1                            1
ACTION:SPL 97-09-30 16:22    on                            19970915154530     I
NET WAV EVE UNA  QNX 9709_15_1544_29T.UNA_03_1        STA301622 REQUEST      3
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7
UNA  SZ  P       1545 30.42  313
```

after update:

```
1997  915 1545 30   L                       UNA  1                            1
ACTION:SPL 97-09-30 16:22    on                            19970915154530     I
NET WAV EVE UNA  QNX 9709_15_1544_29T.UNA_03_1        STA301622 TRANSFERRED  3
9709-15-1544-29S.UNA_003                                                      6
STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7
UNA  SZ  P       1545 30.42  313
```

In Table 2 a combination of connection type, station type and the corresponding data transfer format are shown. For SEISLOG stations on Internet the transfer is binary, while it is ASCII for the modem stations. For IRIS stations in this version of SEISNET there is no difference between Internet and modem stations. In both cases, modem and Internet, the ASCII as well as the binary transfer is supported. The ASCII transfer is done as variable ASCII, where the data are captured from the screen. The binary transfer is done based on the Kermit transfer protocol. The transfer rate is higher for binary than for ASCII. But since in the binary transfer complete blocks of data and hence a larger amount of data is transferred, in total the ASCII transfer becomes faster. For routine transfer therefore it is recommended to use the ASCII transfer. 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.

Table 2. List of combinations of station type, connection type and data transfer format supported in this version of SEISNET.

Station type	Connection type	Data Transfer Format
SEISLOG - QNX	Internet	SEISLOG, binary
SEISLOG - QNX	Modem	SEISLOG, ASCII
IRIS / GSN	Internet	FTP, binary
IRIS / GSN	Internet	variable ASCII
IRIS / GSN	Modem	variable ASCII
IRIS / GSN	Internet	Kermit BINARY
IRIS / GSN	Modem	Kermit BINARY
FTP	Internet	ASCII / BINARY
AutoDRM	Internet	GSE ASCII

(6) Transfer requested waveform data for a single station

This is the same function as 'transfer requested waveform files for all stations', but for a single station that is selected from a list of stations. The only difference is that in case of an error there is no retry.

(7) Instantaneous waveform data transfer for selected event

This option starts the program SEVEN, 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.

(8) Get continuous 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 and AutoDRM. The option (1) has to be used if there is no entry in the data base, means some event was not detected on any of the seismic nodes. The (2) option will start the program SEVEN that makes it possible to select some event from the database.

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

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

( b) back

choice ?
```

This option 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 with is given for each station in the parameter file. 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 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.

(9) 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 transfer data for a few stations that are close to the epicenter in case an earthquake is reported felt.

(10) Login to station

This function can be used to login to a station.

```
(11) QNX submenu
```

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

```
 QNX SUBMENU
 ===========

 ( 1) FTP QNX station  (INTERNET only)
 ( 2) check station time/running
 ( 3) Change station parameter files
 ( 4) Test modem connection

 ( b) back

 choice ?
```

(1) FTP QNX station

FTP will be started to transfer data from a SEISLOG system that is connected to Internet.

(2) Check station time/running

This is a function to check if a 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 program and compared to the time in the data center. Then the MON program (Utheim, 1997) is started. If the time only comes up once, the station is not running and the user will be asked if the system should be restarted. If the time is received twice, the station is running OK.

(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 in 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.

(12) 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)

```
AUTODRM SUBMENU
===============
( 1) check for incoming AUTODRM data
( b) back
choice ?
```

(13) SEISNET parameter file submenu

This will open up a submenu:

```
SEISNET PARAMETER FILE SUBMENU
==============================

( 1) edit SEISNET parameter file
( 2) check SEISNET parameter file

( b) back

choice ?
```

(1) edit SEISNET parameter file
You can 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.

(14) eev (last day)

The program EEV (Havskov, 1997) can be started for the station databases, the central database and the log database. The database can be selected from a list. As start-time for EEV the current date is used. This option makes it possible to inspect latest databases within SEISNET.

(15) Station Monitor

This option gives the date and time for the last successful parameter and waveform data transfer. The aim of this option is to give a quick overview on the completeness of the data transfer.

5. Background operation of SEISNET

5.1 Cron

In 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 defined 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 do 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, one 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. 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 several 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 if it does not change within a given time. The lock watcher program is the same seisnet program started with a special flag. It is up to the user to set the time for this and it is important that the watcher should not be started while another watch for the same lockfile is active. 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 deleteted manually.

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 2.0
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
 -h or -help help
 -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
 -mm          master mode, only use MASTER stations
 -pd          start transfer of parametric data
 -pf file     give name of parameter file
 -version     show version of Seisnet
 -wd          start transfer of waveform data
 -ws suffix   set sufffix for waveform request files

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 -ws WAVA -ap -pf
/net/seismo/seismo/NSEISNET/seisnet/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. In this case, SEISNET would be started through an entry in the crontab file like this:

5 5,17 * * * seisnet/EXP/seisnet –au –pd –ed –ws WAV1 –wd –ap –lf lock1 –pf <parameter-file> > /dev/null
1 4,16 * * * seisnet/EXP/seisnet.exp -pf <parameter file> -lf lock1 -lw 8000 > /dev/null

The cron job starts running in the user's home directory, 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. 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>  -au -mm -pd -ed –ws WAV1 –wd -lf lock1  > /dev/null
# start the lock watcher every hour at 5 minutes
5 * * * * seisnet/EXP/seisnet.exp -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:

```
# check incoming mail box every minute, convert if data and update database
* * * * * seisnet/EXP/seisnet.exp -pf <parameter file> -au -ai > /dev/null
# autodrm watch to remove old lock files
1,21,41 * * * *  seisnet/EXP/seisnet.exp -pf <parameter file> -au -aw >/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
- Try to run Seisnet on the screen 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 file exists in the SEISNET work directory
- 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

5.4 Parallel operation

Several parameter files can be used in parallel, which makes it possible to divide a network into sub-networks. This might be essential to speed up the data transfer. If you would use separate working directories (WORKDIRECTORY), there would be no risk of files being overwritten by another process. This can also be avoided when using the same working directories in parallel running processes. In order to do this you need to:

1) start the waveform data transfer with different suffixes for the waveform request files: see option –ws in section 5.3.
2) use different LOG_INDEX variable in seisnet parameter file
3) use different LOG_DATABASE variable in seisnet parameter file

Like this, it is for example possible to support several modems in parallel.

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.

6. Logging

An important part of SEISNET is the logging system. A daily log file lists all data collection processes. Based on this file, a daily summary file is generated for the previous day, when SEISNET is started for the first time a day. This file gives an overview of the data transfer and station status. The times in the log files are GMT, assuming that the system time is set-up correctly. In addition for every data transfer connection, the process is captured in one file.

Daily logfile

For every connection that is started by the routines for parameter detection or waveform data collection, one line is added to a daily log file giving information about the connection and data transfer. For SEISLOG stations, when the detection parameter collection is started for the first time in a day, information on the status of the station is written to the daily logfile. This status information is time difference between station and true time, both the station and clock uptime in percent for the previous day and the disk space that is used in percent. In addition, from SEISLOG stations, the idx_log file is downloaded and the program STALOG is started to determine the station and GPS uptime for the previous day. After data are collected from all stations, this daily log file is put into a SEISAN log database. The name of the log database is given in the parameter file. The log file can be accessed using EEV directly or starting EEV for the log-database from SEISNET. An example of the daily log file is given in Figure 2. The log file has the format of an S-file, the first five lines do not contain any logging information, but they have to be there, since the file is stored in a SEISAN database. Logging information is given from line 6 in type 3 lines (SEISAN, description of Nordic format). The format of such a logging line is:

col 2 - 9 : GMT Unix system time at beginning of connection
col 11 - 14 : Station name
col 16 - 18 : Code indicating if waveform data (WAV) or parameter (PAR) transfer
col 20 - 27 : station time for SEISLOG
col 29 - 33 : time difference between station and true time for SEISLOG
col 35 - 39 : station uptime for previous day for SEISLOG
col 41 - 45 : clock uptime for previous day for SEISLOG
col 47 - 49 : disk space used in percent for SEISLOG
col 51 - 53 : number of detections since last transfer
col 51 - 79 : Message about errors or OK, if data collection was successful
col 80 –80: line type 3 indicator for comment line

Example of daily logfile:

```
12345678901234567890123456789012345678901234567890123456789012345678901234567890

 1998 0123 0300 04.0 L                        LOG                                1
 ACTION:SPL 98-01-23 08:59 OP:on   STATUS:              ID:19980123030004     I
 STAT SP IPHASW D HRMM SECON CODA AMPLIT PERI AZIMU VELO SNR AR TRES W  DIS CAZ7
 1998 0123 0300 04.0 L                        LOG                                1
 Fri Jan 23 1998                                                                 3
 CENTRAL          STATION                                                        3
 HH:MM:SS NET  TYP hh:mm:ss  DIFF  STA%  GPS% DU% NOD -- MESSAGE --         ERR 3
--------------------------------------------------------------------------------3
 03:00:04 TRO  PAR 03:00:24  -1.0  66.2 100.0 65%  10                            3
 03:00:50 ASK  PAR 03:01:06   0.0  88.9 100.0 46%   2                        *** 3
 03:01:15 TRON PAR 03:02:39   0.0 100.0   0.0 69%   2                        *** 3
 03:02:55 KMY  PAR 03:04:11   0.0 100.0 100.0 54%   0                            3
 03:04:20 HYA  PAR 03:05:36   0.0 100.0 100.0 56%   3                            3
 03:05:52 SUE  PAR 03:06:22   1.0 100.0   0.0 92%   3                        *** 3
```

```
03:06:41 KONO PAR ------------------------------   2                              3
03:06:51 KBS  PAR ------------------------------   1                              3
03:07:16 RUND PAR ---------------------------------- not ACTIVE                  3
03:07:16 MOR8 PAR 03:08:02   0.0             26%   4                              3
03:08:41 BJO  PAR ---------------------------------- not ACTIVE                  3
03:08:41 PDE  PAR ----------------------------------                              3
03:08:52 ODD1 PAR 03:10:09  -1.0 100.0 100.0 87%   5                              3
03:10:22 FOO  PAR 03:11:41  -1.0  40.3 100.0 68%  22                          *** 3
03:12:16 MOL  PAR 03:13:21  -2.0  98.6 100.0 66%  18                          *** 3
03:13:34 LOF  PAR 03:14:38  -1.0  98.6 100.0 65%   0                              3
03:15:25 TRO  WAV -------- TRANSFER:  15   DONE:  10                          *** 3
03:16:16 ASK  WAV -------- TRANSFER:   2   DONE:   2                              3
03:16:26 TRON WAV -------- TRANSFER:   2   DONE:   2                              3
03:17:27 KMY  WAV -------- TRANSFER:   0   DONE:   0                              3
03:17:27 HYA  WAV -------- TRANSFER:   3   DONE:   3                              3
03:18:40 SUE  WAV -------- TRANSFER:   3   DONE:   3                              3
03:19:59 KONO WAV -------- TRANSFER:   6   DONE:   6                              3
03:21:36 KBS  WAV -------- TRANSFER:   3   DONE:   3                              3
03:23:09 RUND WAV -------- TRANSFER:   0   DONE:   0                              3
03:23:09 MOR8 WAV -------- TRANSFER:   4   DONE:   4                              3
03:25:53 BJO  WAV --------                   WAVEFORM NO                         3
03:25:53 ODD1 WAV -------- TRANSFER:   5   DONE:   5                              3
03:27:40 FOO  WAV -------- TRANSFER:   5   DONE:   5                              3
03:29:27 MOL  WAV -------- TRANSFER:  18   DONE:  18                              3
03:35:09 LOF  WAV -------- TRANSFER:   0   DONE:   0                              3
```

Daily summary logfile

When SEISNET is started for the first time a day, a summary logfile is generated based on the daily logfile for the previous day. This file gives a good overview on the data transfer and station status. The file is written to the log-database for the time 00:00, and will therefore be the first file for a day, which is shown in eev. An example of the daily logfile is shown in figure 3.

The first line is giving the date of the logfile. The number of transfers, detections, etc. given in the file are for this day, while the station and GPS uptime are for the previous day. The abbreviations given for information in the third line are:

NET : name of network
CON : number of successful connections for detection parameter and waveform transfer
NOD : number of detections on the network
REQ : number of requested waveform files
TRA : number of transferred waveform files
TIMED : time difference between station and data center (only SEISLOG)
STAUP : uptime of station in percent (only SEISLOG)
GPSUP : uptime of station GPS clock in percent (only SEISLOG)
DU : disk space used in percent (only SEISLOG)
ERR : three stars indicate error

Example of daily summary logfile:

```
12345678901234567890123456789012345678901234567890123456789012345678901234567890

 1998  414 0000 00.1 LL                        LOG                                1
 ------------------------------------------------------------------------------3
 NET  CON     NOD REQ TRA TIMED STAUP GPSUP DU%                              ERR 3
 ------------------------------------------------------------------------------3
 TRO    3       7  15  15 -55.0 100.0   0.0  69                              *** 3
 WNN    3       0   1   1   1.0 100.0  86.1  57                              *** 3
 TRON   3       1   5   5   2.0 100.0  90.3  72                              *** 3
 KMY    3       3   6   6 -22.0 100.0   0.0  55                              *** 3
 HYA    3       9  15  15   0.0 100.0  98.6  59                                  3
 SUE    5      11  12  12   0.0 100.0  80.6  85                              *** 3
 KONO   6       7   0   0   0.0   0.0   0.0   0                                  3
```

```
KBS     3        8  72  72    0.0    0.0    0.0   0                                  3
RUND    3        2  11  11    1.0  100.0   81.9  75                             ***  3
MOR8    3        8  39  39    1.0    0.0    0.0  35                                  3
BJO     6        0   0   0    0.0    0.0    0.0   0                                  3
PDE     3        2   0   0    0.0    0.0    0.0   0                                  3
ODD1    3        1   3   3   -1.0  100.0   95.8  88                                  3
FOO     3        5  17  17    1.0  100.0   98.6  70                                  3
MOL     3        3  11  11   -1.0  100.0  100.0  58                                  3
LOF     3        2   9   9   -2.0  100.0  100.0  68                             ***  3
KTK     3        0   0   0    0.0    0.0    0.0   0                                  3
NSS     3       19   0   0   -1.0   72.2   94.2  67                             ***  3
BLS5    3        0   0   0    0.0    0.0    0.0   0                                  3
-------------------------------------------------------------------------------------3
ACTION:NEW 98-04-15 04:00 OP:LOG  STATUS:              ID:19980414000001          I
NET ASO YES                                                                        3
```

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. These 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 without 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. Acknowledgements

The basic idea of SEISNET stems from Jens Havskov, who with ever-new ideas has pushed the development of SEISNET forward. I am thankful to 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 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.

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