Using SEISAN with SeisComP

Comparison and tutorial

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October 2024

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Introduction

In this document we will present the two processing systems SEISAN and SeisComP and give a tutorial of how they can be used together. We focus on the manual analyzing and QC of both raw and parameterized data, and we hope that users of one or both systems will find this tutorial helpful. In the first part of the document, we will give a short description of the history of the two systems as well as a summary of the main capabilities. In the second part there will be a tutorial of how to use the two systems together.

Software for processing

Many software toolboxes have been developed to process earthquake data, however in recent years there are only a few well documented available in the public domain. Some systems consist of a set of tools that can be combined to solve particular tasks like ObsPy (https://www.geophysik.uni-muenchen.de/~megies/www_obsrise/). For signal processing SAC (http://ds.iris.edu/ds/nodes/dmc/software/downloads/sac/) is widely used. Considering a complete system for routine analysis and data storage, the only large well distributed systems are SEISAN and SeisComP.

Both systems originated more than 30 years ago in the academic community due to a particular need and then developed to be widely used.

SeisComP

The system originated as a data acquisition and communication system and then evolved into an automatic tsunami warning system and was mostly made for automatic detection and analysis of teleseismic events (Weber et al. 2007, Hanka et al. 2010, Weber et al., 2023). SeisComP has both advanced automatic processing and interactive analysis. Later it was also set up for detecting local events and now includes a sophisticated manual processing system. SeisComP has a very advanced display system showing data in real time and locations and magnitudes of the latest detection. Detection parameters are stored in a relational data base and the continuous waveform data is stored in a day-files (one per channel) in a flat file data base (the so-called SeisComP Data Structure (SDS)), which is now used by other systems as well. When manual processing a particular event, the user finds the event in a list of events and then calls up the plot to process. The data is read from the continuous archive. The modified data is then returned to the data base. The manual processing can be phase pick, location, magnitude and a few others. SeisComP is probably the most widespread data acquisition system in use (more than 500 installations, Weber et al., 2023). In terms of manual processing, other systems are also used in connection with SeisComP. SeisComP is maintained by a commercial company (Gempa GmbH, see https://www.gempa.de) and the basic software is open and free but specialized modules have a cost. However, since SeisComP is so widely used, there are many free plugins that do other tasks like e.g. real time moment tensor inversion. SeisComP has extensive online documentation (https://www.seiscomp.de/doc/) as well as tutorials (https://www.seiscomp.de/doc/base/tutorials.html). Gempa organizes SeisComP courses (for a fee).

SEISAN

SEISAN (Havskov and Ottemöller, 1999, Havskov et al., 2020) was initially made for processing single events and there was therefore one or several waveform file(s) with one corresponding parameter file in Nordic format (S-file). Both type files are organized in a flat file data base for easy access. SEISAN supports many different waveform formats but today MiniSeed is the most used. To process a particular event, an interactive event editor (graphical or prompt line) is used to point to the event. The user then has options for a large number of operations (>100) like plot, location, magnitudes, fault plane solutions as well as many options to manually or automatically modify the data in the S-file. SEISAN also supports continuous waveform data and uses the same SDS archive structure as SeisComP so when processing an event, the S-file can point to a waveform file or a time section in the archive or both. SEISAN has recently also developed a simple data detection program reading data from the archive, so it operates a few minutes behind real time. It is simple to set up but does not have the sophistication of SeisComP. SEISAN is widely used, and many institutions report data processed with SEISAN to the ISC. In 2024, 24 % of institutions reported to ISC in Nordic format (Harrison, personal communication) while in 2011 it was 27%. SEISAN has many offline programs working on the data base or individual files with many events. This includes several research type programs program. SEISAN is maintained mainly by its current authors (Ottemöller, Havskov and Voss) as well as some of its users. All software is open and free. SEISAN has a detailed manual as a PDF (550 pp) or online (see https://seisan.info/ and several tutorials. At regular intervals SEISAN workshops have been held, in recent time mostly web based. The last workshop was in 2024.

What to use?

SeisComP is the most professional and has the best graphical user interface for both manual processing and real time display and the automatic processing is very good, and it includes many more automatic options than SEISAN. It has a SQL data base that many users want. If, for manual processing, the user is happy with the parameters and options available, then SeisComP is the best choice. A drawback is that SeisComP has little built-in software for input and output, but scripts can be made to do that.

SEISAN can do the same manual processing as SeisComP, however it has additional options not found in SeisComP. The processing speed when picking phases is similar for the two systems. Both systems have many shortcuts to make routine processing faster.

The main difference between SEISAN and SeisComP is how to use the data once processed and stored in the respective data bases. SEISAN has programs, and commands not available in SeisComP to work with the data like e.g. taking a subset of data under certain criteria and working only with that subset like relocating with a new model. Some of these SEISAN options can be made with scripts in SeisComP. SEISAN also has options for including older data in form of parameters and individual events waveform files in different format so if moving to SEISAN from an older system, it is easy to include all data. It is simple to take out a subset of data from SEISAN including parameter, event waveforms and response files and move to another Linux or Windows system and continue processing. So, the flexibility and simplicity in SEISAN is its biggest advantage compared to SeisComP.

These differences in the two systems are a result of the systems developing from opposite start points. SeisComP started as an automatic system with little or no manual processing and slowly added manual processing since there clearly was a need. SEISAN started with only manual processing and slowly moved to some limited real time acquisition and automatic processing. For this reason, SeisComP is very good at all automatic processes while SEISAN has more facilities for manual processing.

Best of both worlds

Many institutions have chosen to use SeisComP for the initial triggering and automatic processing, possibly also manual processing, and then manually or automatically transfer the data to SEISAN for further work. In a survey in 2019 (Havskov et al., 2019) 52% of SEISAN users used SeisComP for data acquisition while 19% used EarthWorm. SEISAN has manual and automatic programs to move data from SeisComP to SEISAN.

Tutorial for using SEISAN with SeisComP

SEISAN can use SeisComP in two ways. The simplest is only use the continuous waveform data base. In a more integrated mode, SEISAN also reads from the SQL data base and SeisComP commands are used and SEISAN must have login access to the SQL data base. In the following descriptions it is assumed that the user has a basic knowledge of SEISAN.

Configuring the SeisComP archive in SEISAN

In order for SEISAN to be able to read the SeisComP waveform data, the channels the user wants to use must be defined in the parameter file SEISAN.DEF (section 3.1.3). SEISAN can optionally define several different SeisComP archives but in this example, we will use the option for one archive, for detail see manual section 2.2.3. The line to give the location of the archive in SEISAN.DEF is e.g.

```
ARC_ARCHIVE                         /home/seiscomp/seiscomp/var/lib/archive
```

which shows the directory under which the archive is installed.

The channel definitions are e.g.

```
ARC_CHAN                            BER  HHZNS00
ARC_CHAN                            BER  HHNNS00
ARC_CHAN                            BER  HHENS00
ARC_CHAN                            BLS5 HHZNS00
ARC_CHAN                            BLS5 HHNNS00
ARC_CHAN                            BLS5 HHENS00
```

where the station, component, network and location are given. Optionally validity time for the channels can be given. For a small network the channel definitions can be done by hand but for a large installation, there is a program GET_ARC_CHANNELS (section 18.8) for finding all channels in the archive and writing them out in the format for the SEISAN.DEF file:

Go to archve top directory and make a list of all channels in file e.g. archive.list:

```
ls -R >archive.list
```

and then use program get_arc_channels:

```
get_arc_channels
 Input file name
archive.list
 Output format, arc_chan (def=enter) or arc_chan2(=2)

 Which channels like HHE or **Z, enter for all, else one per line
 * is wild card

 Which networks, enter for all, else one per line

 Which stations, enter for all, else one per line

 ASK   HHE NS 00       2024         272        2024         303
 ASK   HHN NS 00       2024         272        2024         303
 ASK   HHZ NS 00       2024         272        2024         303
 BER   HHE NS 00       2024         272        2024         303
……
……
```

The output file

```
ARC_CHAN                                ASK  HHENS00        2024 928  20241029
ARC_CHAN                                ASK  HHNNS00        2024 928  20241029
ARC_CHAN                                ASK  HHZNS00        2024 928  20241029
ARC_CHAN                                BER  HHENS00        2024 928  20241029
```

It is seen that the time range of data available is added to the end of the line. The more complete ARC_CHAN2 specification is:

```
ARC_CHAN2                               ASK  HHENS00     2024 928 20241029 arc_loc
ARC_CHAN2                               ASK  HHNNS00     2024 928 20241029 arc_loc
ARC_CHAN2                               ASK  HHZNS00     2024 928 20241029 arc_loc
ARC_CHAN2                               BER  HHENS00     2024 928 20241029 arc_loc
```

where each channel can belong to different archives specified by arc_loc. In this way SEISAN can work with different archives at the same time as e.g. if data from field campaign should be available together with data from a permanent network. Virtual networks with a subset of channels from different archives can also be specified.

Once the archive has been defined, SEISAN is ready to work with the continuous data in archive.

Archive example

The SDS archive consists of day files in MiniSeed format for each channel and organized in flat file structure like e.g. for station ASK Z-channel, the day files are in the following directory:

```
/home/seiscomp/seiscomp/var/lib/archive/2024/NS/ASK/HHZ.D
```

and some day file names are

```
NS.ASK.00.HHZ.D.2024.276
NS.ASK.00.HHZ.D.2024.277
NS.ASK.00.HHZ.D.2024.278
NS.ASK.00.HHZ.D.2024.279
NS.ASK.00.HHZ.D.2024.280
```

where the last number is day of year.

In addition to defining the archive channels, the response files must be given (if not already there) if the user wants to do instrument corrections. The response files are in the CAL directory. Various formats can be used (see section 41). The response files can be extracted from SeisComP in RESP format, see example later.

SEISAN programs working with the archive and/or the SQL data base.

Several SEISAN programs work with the archive in SeisComP and only one program, SCPNOR, also works with the SQL data base. Continuous data organized in a SesiComP structure is quite popular and is often set up by other systems than SeisComP. Note that all programs except SCPNOR work in both Linux and Windows.

SCPNOR: The main program for getting a complete data set from SeisComP meaning S-files and waveform event files, see section 21.8.

MULPLT: Plotting a time window from the archive and extracting a time segment, see section 8. Also for general plotting of waveforms.

GET_ARC: Extract waveform segments corresponding to events in an S-file and updating the S-file with the filename of the extracted waveform file, see section 18.7.

NETDET: Run an offline or real time detection and waveform extraction process using selected channels in the archive, see section 21.7.

CONGAP: Check archive for time gaps, see section 18.3.

CONNOI: Make noise spectra, see section 18.4.

CORR: Using cross correlation, find events in the continuous data resembling a master event, see section 43.

CONDET: An earlier version of NETDET which also can run on the original SEISAN continuous waveform data base, see section 21.6.

WAVETOOL: Extract data from the archive in various formats. For one event, it is simplest to use MULPLT. See section 18.6.

Program examples

In the following, examples will be shown of using some of the programs. Special attention is given to sections marked with yellow and corresponding comments in read. Many programs in SEISAN will use input S-files assuming the S-files give a proper link to the waveform data, either using an ARK line, a general reference to the archive or individual waveform event files. These programs are not mentioned above since they are not specifically using an archive. Programs like AUTOMAG (observations for magnitudes), SPEC (spectral analysis), AUTOPIC (picking phases) KAPPA (calculating kappa) and CODAQ (calculating coda Q) are examples of programs needing both S-files and waveform files. They cannot work within the SeisComP environment but by extracting the S-files from SeisComP and possibility the waveform files, the program will work, either with the archive or with the waveform event files. If SeisComP is used as the main manual analysis tool, it is then simple to use all SEISAN programs with the data.

When presenting the SEISAN programs we do not claim that SeisComP cannot do the same or similar or better, but our aim in the tutorial is to present the SEISAN options.

For very a large data set (e.g. 200 stations) and maybe a long time window (like 2 hour for some teleseismic data), it is quite time consuming to read from the archive in both SeisComP and SEISAN and extracting out only waveform files with segments needed, will speed up the processing significantly.

SCPNOR

This program (section 21.8) can extract data out of the SeisComP SQL data base. The program has the following main options:

- Read detection information from the SQL data base and create corresponding S-files in the SEISAN data base or a single directory.
- A link to the archive can optionally be created so SEISAN can plot the waveforms with corresponding picks using the archive.
- Optionally extract waveform files corresponding to the S-files, put the waveform file name in the S-file and store the waveform files in working directory, WAV or a SEISAN waveform database. The advantage of this option is that a complete data set of waveforms and parameters is created that can be moved to another system for more processing independent of the archive and SeisComP.
- Run the process in real time so a mirror SEISAN data base of SeisComP detections is kept updated.

The program uses a parameter file scpnor.par located in DAT or working directory. The following example shows how to do an extraction for a given time period, in this case for October 6, 2024. Comments (in red) are given in text highlighted with yellow:

```
scpnor
seiscomp version    4                     list of parameters used
sql user:           seiscomp
sql pass:           pas-wd-scmp
sql ip  :           localhost
sql data base       seiscomp
make s-file         T
distance indicator  R
insert ARC line     F
wa gain              2800.0
sfile data base     SeisComP
sfile 2. data base
agency operator     BER jh
instant time back    1440.0
pre event time         25.0
post event time       400.0
extract wav for stations with readings
move waveform file to base SeisComP
 Give start time, at least year, yyymmddhhmmss
```

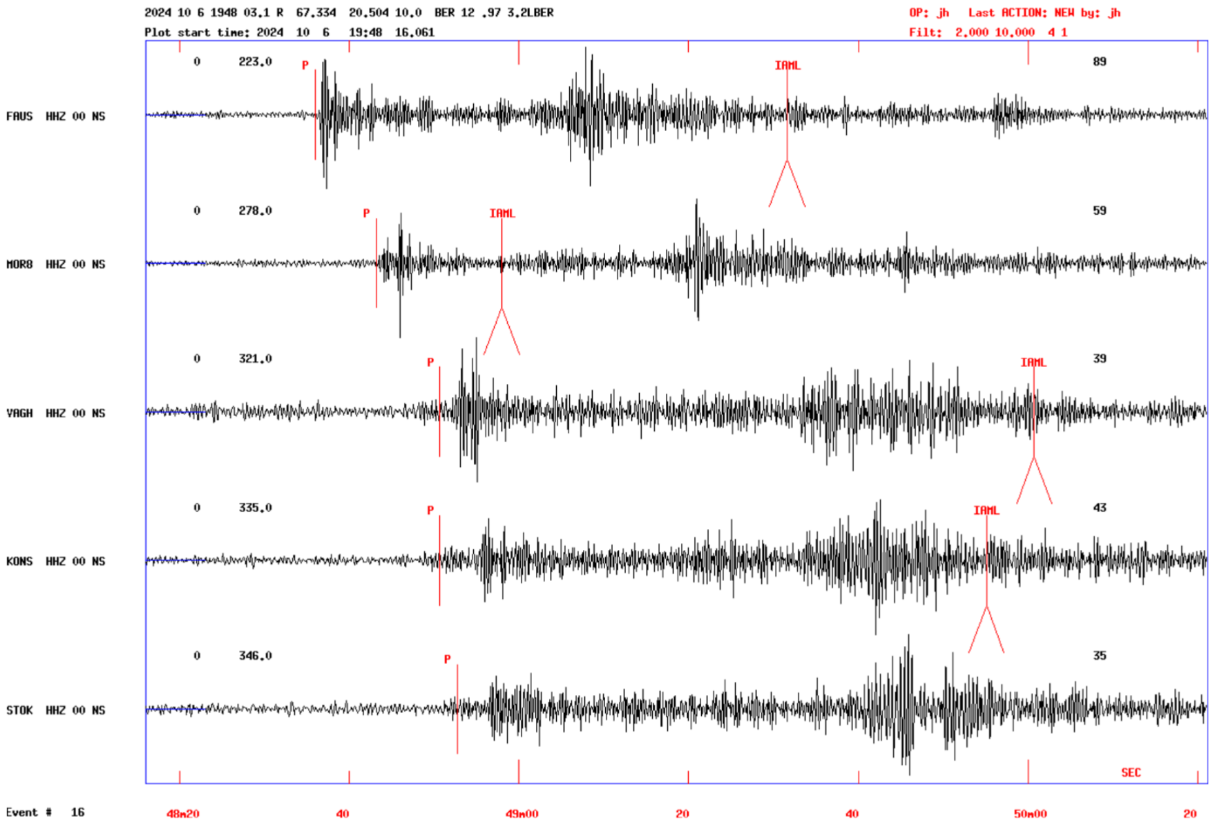
```
20241006
 Give end time, at least year, month and day, yyyymmddhhmmss
 or give number of hours from start like 2 or 0.2
24
begin: "2024-10-06 00:00:00"
end:   "2024-10-07 00:00:00"
scevtls -d mysql://seiscomp:pas-wd-scmp@localhost/seiscomp --begin "2024-10-06 00:00:00" --end
"2024-10-07 00:00:00"  > newids.txt
Number of event ids            5          5 events were found in SeisComP
scbul4.py -d mysql://seiscomp:pas-wd-scmp@localhost/seiscomp -E nsn2024tpuk -3 -e -p > event
Number of station observations in S-file          54
 Different stations for this event:          26
 Number of corresponding channels in archive          31
 wavetool -start 20241006003216 -arc  -duration      425.0 -wav_out_file SEISAN -format MSEED -
cbase cbase.inp      WAVETOOL is used to extract waveform data
 DOMB 00HHZNS   31556908860.000000       66238041660.000000
 DOMB 00HHNNS   31556908860.000000       66238041660.000000
 DOMB 00HHENS   31556908860.000000       66238041660.000000
 HYA  00HHZNS   31556908860.000000       66238041660.000000
 HYA  00HHNNS   31556908860.000000       66238041660.000000
 HYA  00HHENS   31556908860.000000       66238041660.000000
 ODD1 00HHZNS   31556908860.000000       66238041660.000000
 ODD1 00HHNNS   31556908860.000000       66238041660.000000
 ODD1 00HHENS   31556908860.000000       66238041660.000000
 RAUS 00HHZNS   31556908860.000000       66238041660.000000
 RAUS 00HHNNS   31556908860.000000       66238041660.000000
 RAUS 00HHENS   31556908860.000000       66238041660.000000
 STOK 00HHZNS   31556908860.000000       66238041660.000000
 STOK 00HHNNS   31556908860.000000       66238041660.000000
 STOK 00HHENS   31556908860.000000       66238041660.000000
 GILDE00HHZNS   31556908860.000000       66238041660.000000
 GILDE00HHNNS   31556908860.000000       66238041660.000000
 GILDE00HHENS   31556908860.000000       66238041660.000000
 KONS 00HHZNS   31556908860.000000       66238041660.000000
 KONS 00HHNNS   31556908860.000000       66238041660.000000
 KONS 00HHENS   31556908860.000000       66238041660.000000
 LEIR 00HHZNS   31556908860.000000       66238041660.000000
 LEIR 00HHNNS   31556908860.000000       66238041660.000000
 LEIR 00HHENS   31556908860.000000       66238041660.000000
 MOR8 00HHZNS   31556908860.000000       66238041660.000000
 MOR8 00HHNNS   31556908860.000000       66238041660.000000
 MOR8 00HHENS   31556908860.000000       66238041660.000000
 FAUS 00HHZNS   31556908860.000000       66238041660.000000
 FAUS 00HHNNS   31556908860.000000       66238041660.000000
 FAUS 00HHENS   31556908860.000000       66238041660.000000
 VAGH 00HHZNS   31556908860.000000       66238041660.000000
 Number of archive channels defined          31
  Total duration:   425.010010
  Output waveform file name is 2024-10-06-0032-16M.NSN___031
 wavetool completed in   0.09 sec
 Extracted file 2024-10-06-0032-16M.NSN___031
 mv   2024-10-06-0032-16M.NSN___031 /home/seiscomp/seismo/WAV/SeisComP__/2024/10/    move to data
base
 /home/seiscomp/seismo/WAV/SeisComP__/2024/10/2024-10-06-0032-16M.NSN___031
  File transferred to WAV base SeisComP__ **********
  first sfile:   /home/seiscomp/seismo/REA/SeisComP__/2024/10/06-0032-02R.S202410   name of S-
file
scbul4.py -d mysql://seiscomp:pas-wd-scmp@localhost/seiscomp -E nsn2024tpzy -3 -e -p > evento

next event
.
.
```

SCPNOR has now created 5 S-files in the data base and copied corresponding waveform files to the WAV data base SCP. The S-file for the first event transferred is:

```
2024 1006 0032 02.1 R  71.637  -3.169 10.0  BER 26 1.2 4.9LBER 5.1BBER 4.6bBER1
 LOCALITY: Jan Mayen Island Region                                              3
 2024-10-06-0032-16M.NSN___031                                                  6  WAV file name
 SEISCOMP ID: nsn2024tpuk             BER  SeisComP ID is saved                 3
 ACTION:NEW 24-10-07 14:56 OP:jh   STATUS:               ID:20241006003202 R    I
 STAT COM NTLO IPHASE   W HHMM SS.SSS   PAR1  PAR2 AGA OPE  AIN  RES W  DIS CAZ7
 JNW  HHZ NS    P        0032 40.770               BER jh       -2.26     199 253
 ROESTHHZ NS    P        0033 49.970               BER jh       -0.97     745 120
 VBYGDHHZ NS    P        0033 55.660               BER jh       -0.82     790 108
 STEI HHZ NS    P        0033 58.920               BER jh       -0.54     814 111
 TRO  HHZ NS    P        0034 01.180               BER jh       -1.35     839  95
 VAGH HHZ NS    P        0034 02.380               BER jh       -0.73     844 122
 FAUS HHZ NS    P        0034 03.720               BER jh       -0.80     855 115
 GILDEHHZ NS    P        0034 03.760               BER jh       -0.80     855 119
 ISF  HHZ NS    P        0034 07.300               BER jh        2.38     858  26
 KONS HHZ NS    P        0034 03.790               BER jh       -1.13     858 124
 STOK HHZ NS    P        0034 05.470               BER jh       -0.83     869 125
 LOSSIHHZ NS    P        0034 07.550               BER jh       -0.26     881 106
 RAUS HHZ NS    P        0034 08.720               BER jh       -0.22     891 122
 LEIR HHZ NS    P        0034 08.090               BER jh       -0.89     891 126
 MOR8 HHZ NS    P        0034 13.090               BER jh        0.03     924 121
 HAMF HHZ NS    P        0034 17.240               BER jh       -0.75     963  84
 NSS  HHZ NS    P        0034 22.860               BER jh       -0.03    1004 134
 KTK1 HHZ NS    P        0034 25.290               BER jh        0.13    1021  94
 LENS HHZ NS    P        0034 29.010               BER jh        0.02    1053 143
 LADE HHZ NS    P        0034 32.220               BER jh        0.83    1073 141
 MOL  HHZ NS    P        0034 36.150               BER jh        0.65    1106 150
 VADS HHZ NS    P        0034 46.960               BER jh        1.91    1182  83
 DOMB HHZ NS    P        0034 46.750               BER jh        1.35    1186 147
 HYA  HHZ NS    P        0034 53.260               BER jh        2.02    1234 156
 SKAR HHZ NS    P        0035 02.580               BER jh        0.95    1318 152
 ODD1 HHZ NS    P        0035 10.700               BER jh        2.11    1374 157
 ROESTHHZ NS    IAmb     0033 52.660   33.5  0.65 BER jh        0.02     745 120 short distance mb
 VBYGDHHZ NS    IAML     0033 58.300  120.8  1.00 BER jh        0.03     790 108
 VBYGDHHZ NS    IAmb     0033 58.350   70.1  0.90 BER jh        0.22     790 108
 STEI HHZ NS    IAML     0034 01.470  160.2  1.00 BER jh        0.20     814 111
 TRO  HHZ NS    IAML     0035 03.740   86.4  1.00 BER jh       -0.01     839  95
 TRO  HHZ NS    IAmb     0034 05.000   54.1  0.78 BER jh        0.20     839  95
 VAGH HHZ NS    IAML     0036 17.840   55.3  1.00 BER jh       -0.19     844 122
 FAUS HHZ NS    IAML     0034 50.840   62.4  1.00 BER jh       -0.12     855 115
 FAUS HHZ NS    IAmb     0034 15.570   24.1  0.48 BER jh        0.07     855 115
 GILDEHHZ NS    IAML     0034 07.220   83.2  1.00 BER jh        0.01     855 119
 GILDEHHZ NS    IVmB_BB  0034 05.230 1109.6  1.00 BER jh        0.00     855 119
 GILDEHHZ NS    IAmb     0034 05.180   38.3  0.63 BER jh        0.15     855 119
 ISF  HHZ NS    IAML     0036 19.520   72.8  1.00 BER jh       -0.04     858  26
 ISF  HHZ NS    IAmb     0034 09.230   45.8  0.80 BER jh        0.13     858  26
 KONS HHZ NS    IAML     0035 29.960   60.4  1.00 BER jh       -0.12     858 124
 KONS HHZ NS    IAmb     0034 06.770   43.0  1.07 BER jh       -0.03     858 124
 STOK HHZ NS    IAML     0036 23.510   81.8  1.00 BER jh        0.03     869 125
 RAUS HHZ NS    IAML     0035 42.510   57.0  1.00 BER jh       -0.07     891 122
 LEIR HHZ NS    IAML     0034 10.740   96.7  1.00 BER jh        0.16     891 126
 LEIR HHZ NS    IAmb     0034 11.490   53.3  1.41 BER jh       -0.03     891 126
 MOR8 HHZ NS    IAML     0035 46.980   76.1  1.00 BER jh        0.13     924 121
 MOR8 HHZ NS    IAmb     0034 16.770   23.1  1.15 BER jh       -0.28     924 121
 HAMF HHZ NS    IAmb     0034 26.910   33.5  1.42 BER jh       -0.18     963  84
 NSS  HHZ NS    IAmb     0034 44.230   52.1  2.90 BER jh       -0.26    1004 134
 KTK1 HHZ NS    IAmb     0034 36.320   36.7  0.86 BER jh        0.12    1021  94
 LADE HHZ NS    IAmb     0034 36.860   37.4  2.14 BER jh       -0.24    1073 141
 MOL  HHZ NS    IAmb     0034 55.410   75.9  2.35 BER jh        0.04    1106 150
 VADS HHZ NS    IAmb     0035 05.890   63.1  2.08 BER jh        0.04    1182  83
```

Note that SeisComP has extended the mb and MB (broad band mb) magnitude scales to below 20 degrees so for this regional event, SeisComP has calculated Ml and in addition mb and MB.

Below is a plot of a local event detected by SeisComP and transferred to SEISAN. Only some channels are shown. The data is filtered from 2-10 Hz. The automatic picks of P and IAML are shown.



When SCPNOR works in real time mode (started with a crontab), data for user specified period back in time from real time is collected. There is a check that no duplicates are collected.

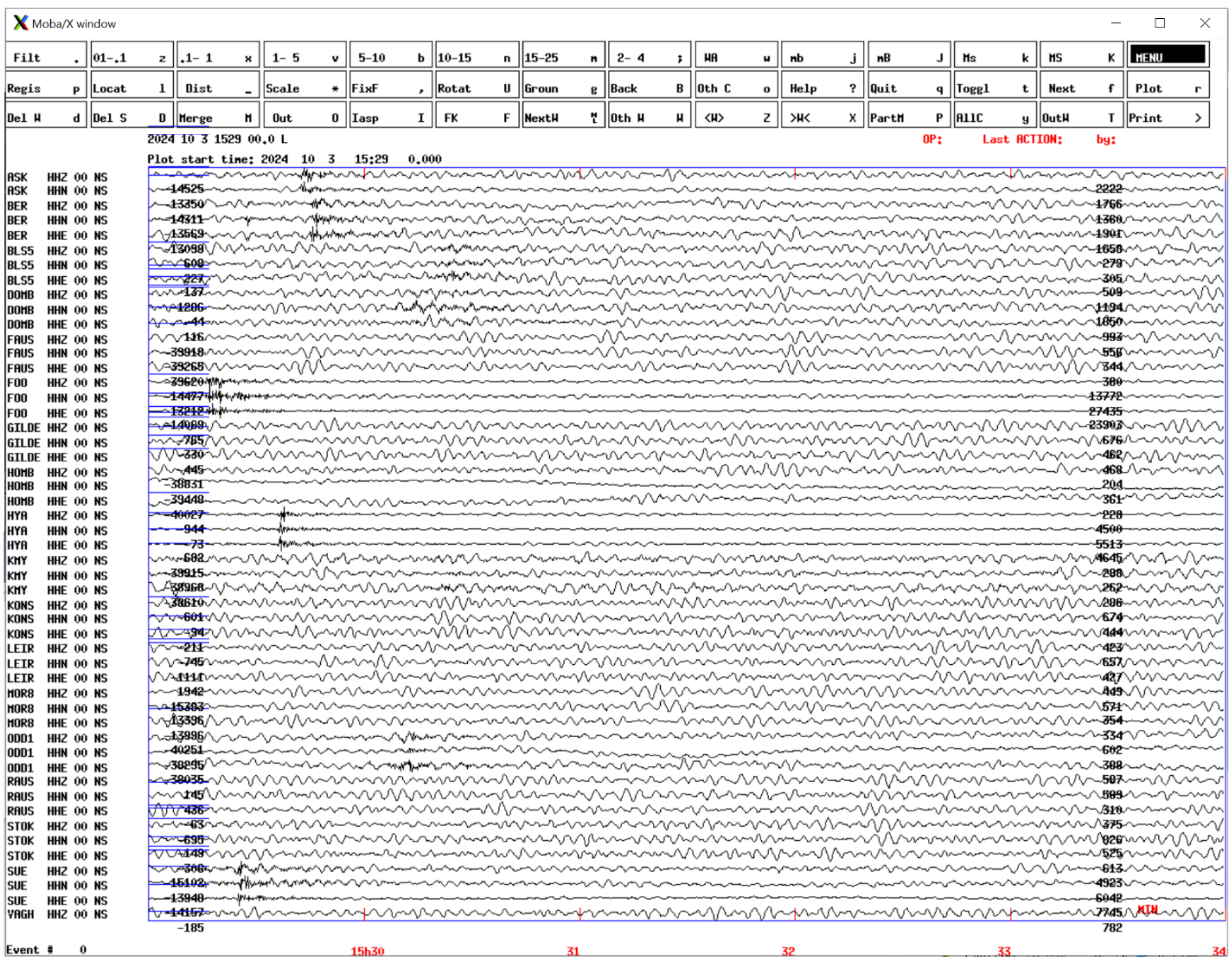
MULPLT

MULPLT is the main program in SEISAN to plot waveforms and it can plot single files or data from an archive. Below is an example of plotting from the SeisComP archive without reference to any event:

```
 mulplt
  Filename, number, filenr.lis (all)
  Continuous SEISAN data base: cont
  Large SEED volume: conts
  archive: arc
  Make a choice
arc                   read from archive
 Give start time, yyyymmddhhmmss
202410031529
 Interval in min
5
  Low and high cut for filter, return for no filter

  Number of archive channels with data:          51
```

The option ‘arc’ is to read from the archive defined in SEISAN.DEF. The archive has 51 channels. The following figure is the station selection screen, and all stations have been selected.

Now follows the plot with 51 channels.



Once the plot comes up, there are many options. One can advance or go back and forth in the continuous plot, select other channels or filter or pick phases. If a larger window is selected (e.g. 1 h) and a filter of 3 to 10 Hz is used, it is possible to go through a time period of data and manually find events and then cut them out (option Out) and optionally at the same time create and event in the SEISAN data base (option Regis).

Plotting a time window corresponding to an event in the data base from the event editor EEV

Normally plotting starts from EEV or SeisanExplorer (SE). In order to then plot waveforms from the archive corresponding to a particular event in the data base, the event S-file must have a way of knowing which segment to plot. The most common way is to add an ARC-line to the S-file (command arc in EEV) indicating where to find the data. An example of an ARC line in the S-file is:

```
ARC *               2024 10 4 22 4 20 10000                                 6     line type
```

The ARC line is type 6 line indicating it is a waveform reference. The ARC line gives the start of the segment to plot which in this case is 100 s before the origin time and the duration, 10000 s. Both parameters are defined in the SEISAN.DEF file:

```
ARC_DURATION                             10000.0
ARC_START_TIME                           100.0
```

The ARC line in the S-file can also be created by SCPNOR and in that case the start time and duration is given in the SCPNOR parameter file.

Without an ARC line, the data can be plotted by using a SEISAN.DEF parameter to plot any event in the database without adding an ARC line. Then the following parameter must be set to 1.0.

```
ARC_BY_DEFAULT                           1.0
```

It is thus possible to get access to the continuous waveform data using just an existing S-file or data base of events in Nordic format. It is important to note that this option is not limited to MULPLT but can be used with all programs in SEISAN that need to read waveform data to do a particular analysis for one or several events.

GET_ARC, Extracting waveform data from SeisComP corresponding to a given Nordic file

In case the user has a Nordic S-file with data from an independent source but with stations corresponding to the data in the SeisComP archive, it is possible to extract a waveform file and include the waveform file name in the S-file.

Below is an example of extracting waveform files for 2 events. As shown, there are several options for selecting which stations to extract. The simplest is to extract all stations (with all channels) but in many cases with a large network and small events, it is more convenient to only extract stations with readings.

```
get_arc
 Give operator
jh
 Give input file
events.inp     S-file with 2 events
 Interval in number of seconds before and after origin time
 Default (enter) is 30 and 300
50 500
 Extract stations with readings:                  enter
        all channels in archive:                      a
        for given stations interactively:             s
```

```
        for stations in a file:                        f
        for stations at given distance to epicenter:  d
        for stations to given distance to given point:p   several options for which channels to
extract, here use stations with readings


********* Event    1   2024 1007 1426 04.5 R  66.368  14.580 5.00
 Number of station observations in S-file          16
 Diffent stations for this event:           10
 wavetool -start 20241007142515 -arc  -duration      550.0 -wav_out_file SEISAN -format MSEED -
cbase cbase.inp
 RAUS 00HHZNS   31556908860.000000        66238041660.000000
 RAUS 00HHNNS   31556908860.000000        66238041660.000000
 RAUS 00HHENS   31556908860.000000        66238041660.000000
 STOK 00HHZNS   31556908860.000000        66238041660.000000
 STOK 00HHNNS   31556908860.000000        66238041660.000000
 STOK 00HHENS   31556908860.000000        66238041660.000000
 GILDE00HHZNS   31556908860.000000        66238041660.000000
 GILDE00HHNNS   31556908860.000000        66238041660.000000
 GILDE00HHENS   31556908860.000000        66238041660.000000
 KONS 00HHZNS   31556908860.000000        66238041660.000000
 KONS 00HHNNS   31556908860.000000        66238041660.000000
 KONS 00HHENS   31556908860.000000        66238041660.000000
 LEIR 00HHZNS   31556908860.000000        66238041660.000000
 LEIR 00HHNNS   31556908860.000000        66238041660.000000
 LEIR 00HHENS   31556908860.000000        66238041660.000000
 MOR8 00HHZNS   31556908860.000000        66238041660.000000
 MOR8 00HHNNS   31556908860.000000        66238041660.000000
 MOR8 00HHENS   31556908860.000000        66238041660.000000
 FAUS 00HHZNS   31556908860.000000        66238041660.000000
 FAUS 00HHNNS   31556908860.000000        66238041660.000000
 FAUS 00HHENS   31556908860.000000        66238041660.000000
 VAGH 00HHZNS   31556908860.000000        66238041660.000000
 Number of archive channels defined          22
  Total duration:   550.010010
  Output waveform file name is 2024-10-07-1425-15M.NSN___022
 wavetool completed in   0.54 sec
 Extracted file 2024-10-07-1425-15M.NSN___022
********* Event    2   2024 1008 0017 09.5 R  69.505  19.958750.0
 Number of station observations in S-file          17
 Diffent stations for this event:           10
 wavetool -start 20241008001620 -arc  -duration      550.0 -wav_out_file SEISAN -format MSEED -
cbase cbase.inp
 RAUS 00HHZNS   31556908860.000000        66238041660.000000
 RAUS 00HHNNS   31556908860.000000        66238041660.000000
 RAUS 00HHENS   31556908860.000000        66238041660.000000
 STOK 00HHZNS   31556908860.000000        66238041660.000000
 STOK 00HHNNS   31556908860.000000        66238041660.000000
 STOK 00HHENS   31556908860.000000        66238041660.000000
 GILDE00HHZNS   31556908860.000000        66238041660.000000
 GILDE00HHNNS   31556908860.000000        66238041660.000000
 GILDE00HHENS   31556908860.000000        66238041660.000000
 LEIR 00HHZNS   31556908860.000000        66238041660.000000
 LEIR 00HHNNS   31556908860.000000        66238041660.000000
 LEIR 00HHENS   31556908860.000000        66238041660.000000
 MOR8 00HHZNS   31556908860.000000        66238041660.000000
 MOR8 00HHNNS   31556908860.000000        66238041660.000000
 MOR8 00HHENS   31556908860.000000        66238041660.000000
 VAGH 00HHZNS   31556908860.000000        66238041660.000000
 Number of archive channels defined          16
  Total duration:   550.010010
  Output waveform file name is 2024-10-08-0016-20M.NSN___016
 wavetool completed in   0.04 sec
 Extracted file 2024-10-08-0016-20M.NSN___016
End of s-file
```

```
 Number of events in input file           2
 Number of events skipped                 0
 Output file name is get_arc.out   this file is the same as the input file with waveform file
names added
```

NETDET, event detection with SeisComP data

NETDET is a simple SEISAN program for event detection based on the continuous archive for a given time window. Running the program as cronjob, it is possible to detect events close to real time. The program uses the standard STA/LTA detector with filtered data and declares events using an array propagation window. A potential use of the program in connection with SeisComP is to test combinations of trigger parameters to investigate possible changes in SeisComP parameters to improve triggering. This could also be used to focus on a particular group of stations to rerun the triggering process on already recorded data. Another use is to find events in a large data set of field recordings. Below is an example of running NETDET interactively. This gives a lot of output since data is read in, in one min segments and info printed out for every minute of data.

```
netdet
Agency and operator:                   TES jh       the parameter file
Netdet directory:                      /home/seiscomp/seismo/netdet
Debug and debug station:                 F  FOO
Number of channels for trigger:        10
Filter:                                2.0   7.0
STA and LTA duration:                  3.0 300.0
Trigger  and detrigger ratio:          3.0   2.0
Trigger minimum duration:              5.0
Minumum trigger interval:             30.0
Preevent time and ext duration:       60.0 300.0
Real time delay in secs:             600.0
Autopic:                               0.0
Min. numb of stats for local lo:         4
Min. numb of stats for dist. lo:        99
Fix depth, if neg. do not fix         12.0
Filters for distant event detec        7.0  14.0
Min trig. for dist. event detec          4
Min. numb of stats for email:           99        email can be sent
Min. magnitude for email:              2.0
System command after location:
Net window and min no of dets:        50.0     3
Make waveform file:                      T
Make s-file and base of  S-file:         T TEST
Copy wav file:                           T
Base to copy wav to;                     TEST

 Archive channels are:
     ASK  HHZNS00
     ASK  HHNNS00
     BER  HHZNS00
     BER  HHNNS00
     BER  HHENS00
.
.
.
.

Archive is: /home/seiscomp/seiscomp/var/lib/archive
Give start time, at least year and month
20241008
 Give end time, at least year, month and day
 or give number of hours from start like 3 or 0.2
```

```
6               run detection for the first 6 hours of October 8

READ next minute  *******************************
 ASK   HHZ NS00 2024 10-07 23:59:40.0  100.0 10001    channels used for detection
 BER   HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 BLS5  HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 DOMB  HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 HYA   HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 KMY   HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 SUE   HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 ODD1  HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 FOO   HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 HOMB  HHZ NS00 2024 10-07 23:59:40.0  100.0 10001
 READ next minute  *******************************
 ASK   HHZ NS00 2024 10-08 00:00:40.0  100.0 10001
 BER   HHZ NS00 2024 10-08 00:00:40.0  100.0 10001
.
.
.

wavetool -arc -start 20241008001800 -duration    300.0 -format MSEED  -wav_out_file SEISAN
 Number of archive channels defined          51     event detected, extract waveform data
  Total duration:   300.010010
  Output waveform file name is 2024-10-08-0018-00M.NSN___051
 wavetool completed in   0.11 sec
 mv   2024-10-08-0018-00M.NSN___051 /home/seiscomp/seismo/WAV/TEST_/2024/10/  move to WAV base
 /home/seiscomp/seismo/WAV/TEST_/2024/10/2024-10-08-0018-00M.NSN___051
  File transferred to WAV base TEST_ **********
  sfile: /home/seiscomp/seismo/REA/TEST_/2024/10/08-0019-00L.S202410  event in data base TEST

.
.
```

Running a general SEISAN program with only data from SeisComP, example CODAQ

1) Transfer readings and locations from SeisComP to a SEISAN data base with SCPNOR including ARC references.
2) Select events to use with SELECT program.
3) Prepare parameter file
4) Run CODAQ

In this case CODAQ is reading from the archive.

Getting response files from SeisComP

The response files in SeisComP can be extracted in RESP format which SEISAN can read. Below is an example:

Step 1: Extract an xml inventory file, seiscomp is the user and pas-wd-scmp is the password.

```
scxmldump -I -d  mysql://seiscomp:pas-wd-scmp@localhost/seiscomp -o inventory.xml
```

Step 2: Convert inventory file to dataless SEED:

```
inv2dlsv inventory.xml inventory.seedventory.xml
```

Step 3: Extract RESP files:

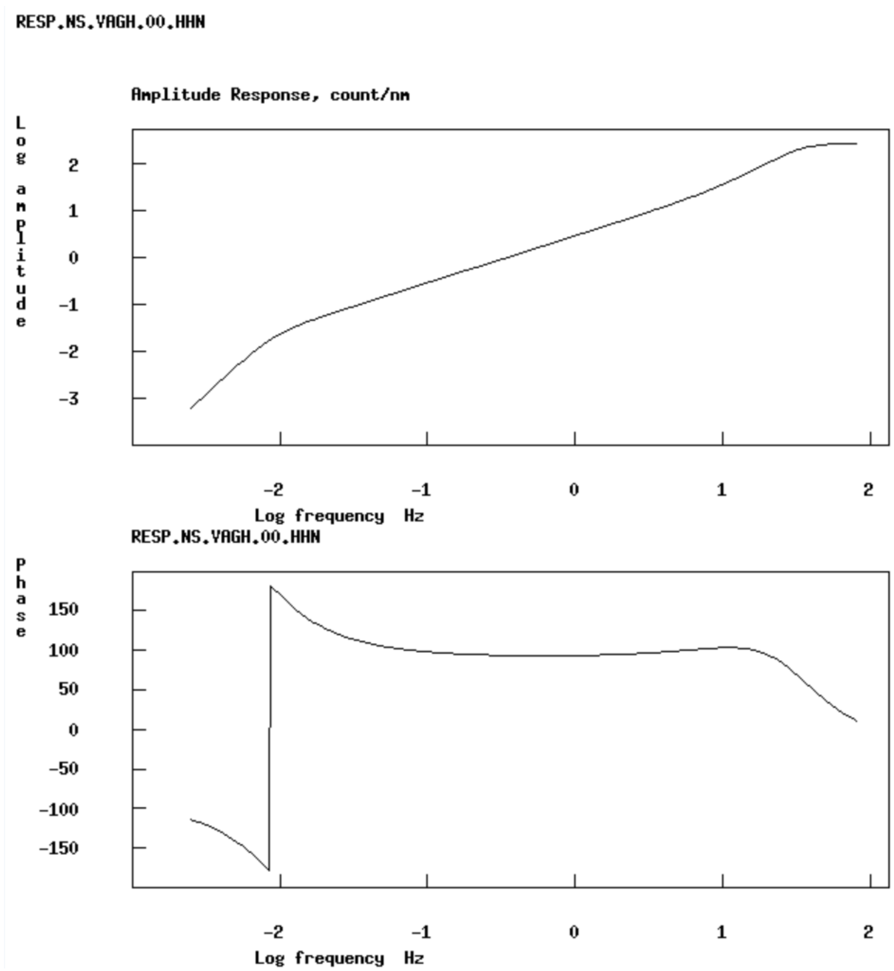
```
rdseed -R -f inventory.seed
<< IRIS SEED Reader, Release 5.3.1 >>
        R = print response data (with addressing for evresp)
        Taking input from inventory.seed
Writing RESPONSE file: RESP.NS.ASK.00.EHE
Writing RESPONSE file: RESP.NS.ASK.00.EHE
Writing RESPONSE file: RESP.NS.ASK.00.EHE
Writing RESPONSE file: RESP.NS.ASK.00.EHE
Writing RESPONSE file: RESP.NS.ASK.00.EHE
Writing RESPONSE file: RESP.NS.ASK.00.EHN
Writing RESPONSE file: RESP.NS.ASK.00.EHN
Writing RESPONSE file: RESP.NS.ASK.00.EHN
```

Note: rdseed is not a part of SEISAN or SeisComP.

The response files can be plotted with program PRESP:

presp RESP.NS.VAGH.00.HHN

and the plot comes up:



From the figure it is seen that this a broad band station where the sensor has a free period of around 100 s.

Summary

By connecting SEISAN to SeisComP, the user has access to all the tools in SEISAN, some of which are not directly available in SeisComP. The user has the option of doing the final manual processing in either SeisComP or SEISAN. However, currently there is no direct SEISAN commands to put event data from SEISAN back to SeisComP although SEISAN can write QuakeMl which be imported by SeisComP. The two systems are quite different, particularly with respect to data storage of parameter data so some tasks might be easier to do in either system. The user's main data base can then be in either system, however having a backup in SEISAN with corresponding waveform segments can facilitate further processing and simplify the process of moving the data to other systems.

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