GFZ
Helmholtz Centre
POTSDAM

GEOFON Training Material

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CHAPTER

ONE

INTRODUCTION

GEOFON operates a global broadband seismic network jointly with many partner institutions with focus on EuroMed and Indian Ocean regions. As of 2016, the network consists presently of 78 high quality stations. Most data is acquired in real-time.

GEOFON also operates a comprehensive data archive for GFZ and partner networks as well as for temporary deployments. Most data is open for public access, including real-time data feeds, if available.

GEOFON operates a global earthquake monitoring system using data from GEOFON and partner networks. It publishes most timely earthquake information, first as automatic solutions, many of which are manually revised later.

1.1 About this guide

This guide is intended to help you get started with SeisComP for acquiring data, and configuring processing; exchanging data and metadata; and using playbacks to test your SeisComP system configuration. At the back are some exercises to test your understanding, and links to further resources.

The guide was prepared through the joint effort of the GEOFON team, including Javier Quinteros, Angelo Strollo, Peter Evans, and others.

CHAPTER

TWO

PREPARATORY HOMEWORK

The first thing that you should have to start with the training is a version of SeisComP3 running on your machine. To do this you are presented with two options. You can use an image from a virtual machine provided by GEOFON, which already has SeisComP3 installed on it (but not configured), or you deploy it on your computer.

Select only one of the two options presented in this chapter.

2.1 Option 1: VirtualBox installation

First, download and install VirtualBox if you do not have a native Linux on your laptop (see the chapter *Download of Resources*).

Then, install the VirtualBox image with SC3 preinstalled.

1. Download the file from http://geofon.gfz-potsdam.de/training/SC3-Trieste.ova . The file has a size of about 3.9 GB. (MD5 sum: a4ccdbf9b78b497ac8a75b10e8875a85 SC3-Trieste.ova)
2. Open the VirtualBox program
3. Go to the menu *File -> Import appliance*
4. Select the *.ova* file downloaded

This may take a few minutes. At this stage you should have a machine loaded into the machine list of the VirtualBox program. Select it from the list, and press "Start".

Consult your instructor for the passwords for the virtual machine that you received. If the system becomes slow, feel free to increase the memory size or to add another disk to the VM.

Warning: The passwords used may be common to many virtual box images, and therefore may be known, or easily guessed, by others. Use this disk image **only behind an institutional or corporarte firewall**. You should not leave the passwords with their default values.

Note: The keyboard layout was configured to be "English". To change it to your preferred language: open the Dash, type "keyboard", open "Text entry", add the layout you want and move it to the top.

This installation comes with a TEMPORARY license for SeisComP3. See *Download and configure the SeisComP3 License file*.

2.2 Option 2: SeisComP3 installation

Warning: These instructions have been tested on (L)Ubuntu 16.04.

2.2.1 Get your native or virtual (L)Ubuntu 16.04 ready

- Start the (virtual) machine and open your home directory
- Add a new user (This is not mandatory; you can install under an existing user directory. Creating a new user is recommended as it allows an easy cleanup of the system later simply by removing the new user if needed)

```
sysop@ubuntu:~$ sudo adduser sysop
sysop@ubuntu:~$ sudo addgroup admin
sysop@ubuntu:~$ sudo usermod -a -G admin,adm,audio sysop
```

- Check the size and the architecture:

```
sysop@ubuntu:~$ df -h
sysop@ubuntu:~$ uname -m
```

2.2.2 Download SeisComP3 binary package, maps and documentation

- Download the SeisComp3 binary package taking into account your Linux distribution and the architecture.
  - Ubuntu 16.04 (and Mint 18) 64 bit
  - Ubuntu 16.04 (and Mint 18) 32 bit
  - Ubuntu 14.04 (and Mint 17) 64 bit
  - Ubuntu 14.04 (and Mint 17) 32 bit
- Alternatively you can download the SeisComp3 binary package from this link (here you will have to fill in the form on the right side of the page the first time you attempt to download a file).
- Download the SeisComp3 maps
- Download the SeisComp3 documentation
- Untar the seiscomp* files (binary package, maps and documentation) you find in your home directory

```
sysop@ubuntu:~$ tar xzf seiscomp3-jakarta-2016.161.01-ubuntu16.04-x86_64.tar.gz
sysop@ubuntu:~$ tar xzf seiscomp3-seattle-maps.tar.gz
sysop@ubuntu:~$ tar xzf seiscomp3-jakarta-2016.062-doc.tar.gz
```

The MD5 checksums for these files are:

```
dc729bf78ff63176153eed738d4307f4  seiscomp3-jakarta-2014.248.01-ubuntu14.04-i686.tar.gz
d8887eb6d64dd7aad5339d96a00d6c7a  seiscomp3-jakarta-2014.248.01-ubuntu14.04-x86_64.tar.gz
d97396d19ac86f2a38676a6900a32dd1  seiscomp3-jakarta-2016.062-doc.tar.gz
faa9dbc5ae8e16e7c4c2ed113475c841  seiscomp3-jakarta-2016.161.01-ubuntu16.04-i686.tar.gz
a582947ce63e8d610a071a33cb38499a  seiscomp3-jakarta-2016.161.01-ubuntu16.04-x86_64.tar.gz
74740745736a93dc86641e4e888806c2  seiscomp3-seattle-maps.tar.gz
```

2.2.3 Download and configure the SeisComP3 License file

- Create a directory with the name “license”

```
sysop@ubuntu:~$ mkdir license
sysop@ubuntu:~$ cd license
```

- Download and save the license files (MD5 sum d129ee6901918c38e41873005307536e) to the “license” directory

```
sysop@ubuntu:~$ tar -xf temporary-license.tar
sysop@ubuntu:~$ cd ~
sysop@ubuntu:~$ mkdir -p .seiscomp3/key
sysop@ubuntu:~$ cp license/key/* .seiscomp3/key
sysop@ubuntu:~$ rmdir license/key
```

This is a TEMPORARY license which may be used for some time after your training is complete. You may arrange a FREE license for non-commercial use at your institution by contacting us at geofon@gfz-potsdam.de . For details, see the README file, and http://www.seiscomp3.org .

2.2.4 Install all dependencies needed and prepare the environment

- For Ubuntu 16.04 and Mint 18:

```
sysop@ubuntu:~$ sudo apt-get update
sysop@ubuntu:~$ sudo apt-get install libxml2 libboost-filesystem1.58.0
 libboost-iostreams1.58.0 libboost-thread1.58.0 libboost-program-options1.58.0
 libboost-regex1.58.0 libboost-signals1.58.0 libboost-system1.58.0 libssl1.0.0
 libncurses5 libmysqlclient20 libpython2.7 python-m2crypto mysql-server
 mysql-client libqtgui4 libqt4-xml
```

- For Ubuntu 12.04 and 14.04:

```
sysop@ubuntu:~$ seiscomp3/bin/seiscomp install-deps base mysql-server gui
```

- For Mint 17:

```
sysop@ubuntu:~$ sudo apt-get update
sysop@ubuntu:~$ sudo apt-get install libxml2 libboost-filesystem1.54.0
 libboost-iostreams1.54.0 libboost-thread1.54.0 libboost-program-options1.54.0
 libboost-regex1.54.0 libboost-signals1.54.0 libboost-system1.54.0 libssl0.9.8
 libncurses5 libmysqlclient18 libpython2.7 python-m2crypto mysql-server
 mysql-client libqtgui4 libqt4-xml
```

- Print the environment variables and copy them to the .bashrc

```
sysop@ubuntu:~$ seiscomp3/bin/seiscomp print env
export SEISCOMP_ROOT=/home/sysop/seiscomp3
export PATH=/home/sysop/seiscomp3/bin:$PATH
export LD_LIBRARY_PATH=/home/sysop/seiscomp3/lib:$LD_LIBRARY_PATH
export PYTHONPATH=/home/sysop/seiscomp3/lib/python:$PYTHONPATH
export MANPATH=/home/sysop/seiscomp3/share/man:$MANPATH
export LC_ALL=C
source /home/sysop/seiscomp3/share/shell-completion/seiscomp.bash

sysop@ubuntu:~$ vi .bashrc
```

- Reload the contents of .bashrc on your current environment

```
sysop@ubuntu:~$ source ~/.bashrc
```

2.2.5 The MySQL SeisComP3 configuration

- Create and add the following lines to the mysql seiscomp3.cnf file.

```
sysop@ubuntu:~$ sudo vi /etc/mysql/conf.d/seiscomp3.cnf
[mysqld]
innodb_buffer_pool_size = 64M
innodb_flush_log_at_trx_commit = 2
```

- Restart mysql.

```
sysop@ubuntu:~$ sudo service mysql restart
mysql stop/waiting
mysql start/running, process 5522
```

2.2.6 SeisComP3 setup and start Graphical User Interfaces (GUIs)

- Run *seiscomp setup* and enter your preferred IDs and password. For the other fields, you can always accept the default values.

```
sysop@ubuntu:~$ seiscomp setup
```

  You should enter an appropriate short name (without spaces) for Agency ID and Datacenter ID. These are used for Arclink and Seedlink, and in the information describing data model objects such as origins and events.

- Enable at least the following modules from the command line. This can also be done from the scconfig GUI

```
sysop@ubuntu:~$ seiscomp enable seedlink slarchive arclink scautopick scautoloc
 scamp scmag scevent fdsnws
```

- Start the scconfig GUI

```
sysop@ubuntu:~$ scconfig
```

If the application runs without problems you have correctly installed SeisComP3. Congratulations!

Hint: (Applicable to the 2016 Myanmar International Training Course only) You should get an updated cities file from GEOFON. Install it in ~/seiscomp3/share:

```
cd ~/seiscomp3/share
wget http://geofon.gfz-potsdam.de/training/cities.xml.gz
mv cities.xml cities.xml.2016.062
gzip -d cities.xml.gz
```

2.3 In case of problems

If, when you attempt to run a seiscomp command such as *scconfig* or *scolv*, you receive an error message like:

```
scconfig: command not found
```

then the most likely explanation is that you have not set your SeisComP environment variables correctly. If you have not installed SeisComP, see the top of this document. Otherwise, run the *seiscomp* command with the full path to where you installed. With the 'print env' option it will show commands you need to enter in your shell. If you installed in the usual way, as user sysop, this is likely to be in *~/seiscomp3/bin*:

```
sysop@host:~$ ~/seiscomp3/bin/seiscomp print env
export SEISCOMP_ROOT=/home/sysop/seiscomp3
export PATH=/home/sysop/seiscomp3/bin:$PATH
export LD_LIBRARY_PATH=/home/sysop/seiscomp3/lib:$LD_LIBRARY_PATH
export PYTHONPATH=/home/sysop/seiscomp3/lib/python:$PYTHONPATH
export MANPATH=/home/sysop/seiscomp3/share/man:$MANPATH
export LC_ALL=C
source /home/sysop/seiscomp3/share/shell-completion/seiscomp.bash
```

These seven lines are not actually run by the 'seiscomp print env' command; you need to cut and paste them into your shell to run them. You can also add these to your .bashrc, .profile, or similar file with commands to be run every time you log in.

You will find that by default SeisComP logs to files in *~/seiscomp3/var/log* and *~/.seiscomp3*. There are four levels of logging (1=ERROR, 2=WARNING, 3=INFO and 4=DEBUG). The level of logging can be adjusted from the default level of 2 in configuration files in *~/seiscomp3/etc/*.cfg* by setting:

```
logging.level = 3
```

or in the GUI for each module. (Open the module configuration, then go to "global" and the "logging" subsection.)

CHAPTER

THREE

CONFIGURING REAL-TIME ACQUISITION WITH SCCONFIG

This chapter shows you how to import metadata for a set of stations into SeisComP. This is enough to begin processing in real time at your own installation.

The steps involved are:

- download metadata for the stations of interest,
- import them into your SC3 system, including bindings,
- view the stations and their traces in the SC3 GUIs.

3.1 Download station metadata

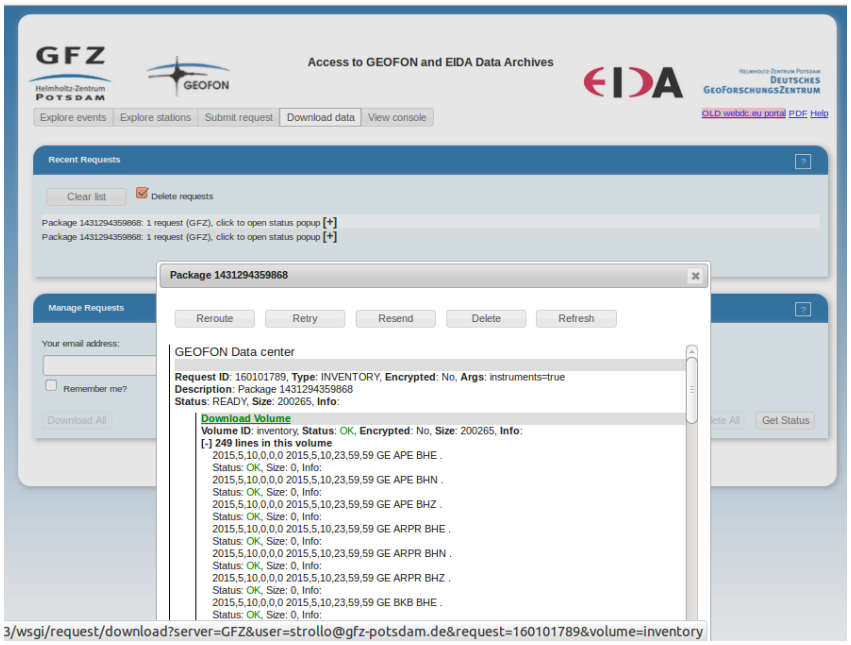
Download an inventory.xml or dataless SEED file from WebDC3 to request GEOFON stations (FDSN network code GE). (For a discussion of metadata formats, see Chapter *Commonly used metadata formats with SC3*.)

- Using the "Explore stations" tab, select the GE network, then 'All Stations'

and BH (20 samples per second) streams

- Move to the "Submit request" tab and select *Metadata (Inventory XML)*. Add your e-mail address and click on the "Submit" button.

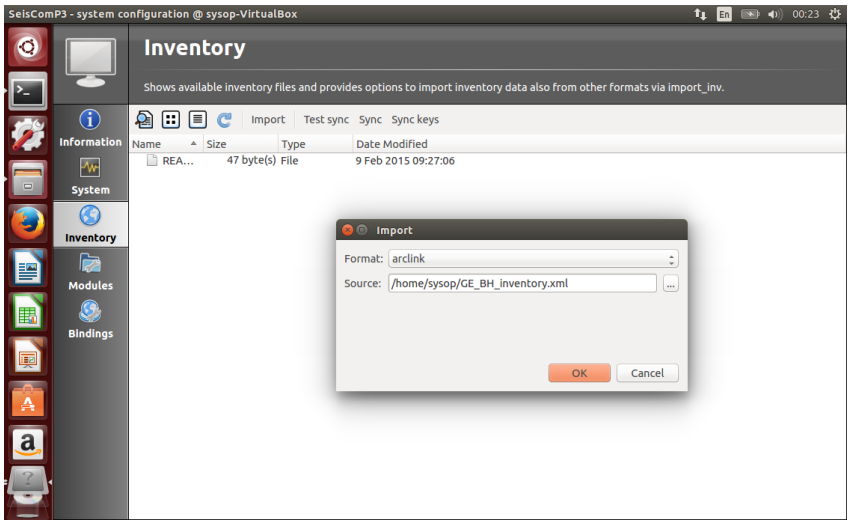
- Move to the "Download data" tab and click on [+] to see more information about the request. Click on "Download Volume" to save the data locally. Save the file as arclink_GE_BH.xml



Note: In case of a slow connection or large processing time, the dataset can be downloaded from http://geofon.gfz-potsdam.de/training/inventory/arclink_GE_BH.xml or http://geofon.gfz-potsdam.de/jakarta-2016/GE-inventory.xml .

3.2 Import the inventory

Start “scconfig” from a terminal. Select the “Inventory” icon on the left side bar.



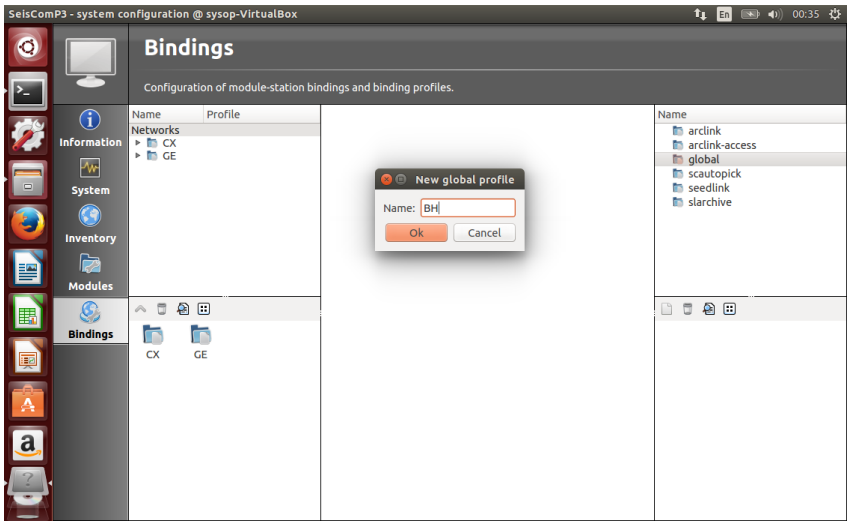
- Click on *Import*, select *arclink* format (for inventory.xml) or any format according to what you would like to import.
- Provide the path to your file in the “Source” field.
- Repeat the last two points you need to add additional metadata (remember to select the right format).
- Press the *Sync keys* button.

3.3 Configure Bindings

In SeisComP terminology, bindings are the connection between SC3 modules and individual stations. Within each module, stations can be differently configured; bindings determine how this happens. Full details are in the SeisComP documentation [1].

In scconfig, select the “Bindings” icon on the left side bar

- Create a global profile named “BH” by clicking with the right button on “global” in the top right panel. Double click on it and set BH as *detectStream* and empty location code as *detecLocID* information.



[1] Online at http://www.seiscomp3.org/doc/jakarta/current/apps/global.html

- If needed you may also create an “HH” global profile.
- Create a *scautopick* profile named “default” (no changes necessary).
- Create a *seedlink* profile named “geofon”. Double click on the profile. Add a chain source with the green plus button on the left (no other changes necessary).
- If you want to archive data, create a *slarchive* profile and name it “default”

  (no other changes necessary).
- Drag and drop all profiles from the right side to the network icon on the left side (you may do that also at the station level).
- Press CTRL+S to save the configuration. This writes configuration files.

3.4 Update the configuration

The SeisComP database must be updated with the inventory and bindings, and the different SC3 modules require a restart to reload with the updated information.

- Go to the system tab and press ESC (to deselect everything)
  1. **Click on “Update configuration”, at the right of the window.** (**Not** “Update”, which just refreshes scconfig’s display of what is running!)
  2. Press *Start* to start acquiring data from the already configured stations.

3.5 Start the GUIs

- Open *scmv* to see a map view of the configured stations.
- Open *scrttv* to see the incoming real-time streams.

If you see colored triangles and traces incoming it means that you have configured your system properly.

With this last step the basic setup is considered to be finished.

CHAPTER

FOUR

ADDING A NEW STATION WITH SMP

In this chapter we prepare metadata for a new seismic station from scratch, using the Station Management Portal (SMP) at https://seismo.gempa.de/smp/login/?next=/smp/ [a product of gempa GmbH, a German software company and GEOFON partner]. We then configure this in an existing SeisComP system.

To add you own seismic station you will of course need a seismic station streaming real-time data and reachable from the SeisComP3 acquisition machine. You will also require the following:

- Internet connection to reach the SMP portal and a valid e-mail address to create an account
- Technical knowledge of your seismic station (sensor and datalogger type, sampling rates, gains, real-time protocol in use and IP on the network)
- Coordinates of your station, name of the station, station/network/channel codes
- Start date (eventually also end date)
- Restrictions

4.1 Preparatory work

- Ensure you can reach your station from your SeisComP3 machine: try to ping the station IP address ...
- If you know your station has a Seedlink server you can also run the following command to check if the server has data available for you:

```
slinktool -Q {IP address}:18000
```

Description of the demo station in use in this particular exercise. The station used here is a very simple demo station. It has all the components of a real seismic station but of course cannot be compared from the performance point of view to a real seismic station. In particular we will be using a demo kit composed of

- Raspberry Pi 3 ($40)
- Educational USB digitizer ($40)
- 4.5 Hz passive seismometer, only one component ($80)
- SeisComP3 software installed on the raspberry Pi (**free!**)
- USB power supply ($10)

4.2 Create the SC3 inventory.xml with SMP

1. Go to the SMP system at https://seismo.gempa.de/smp/login/?next=/smp/
2. Sign up for a new account providing a valid e-mail address to receive the activation message
3. Follow the demo done by the presenter until you are able to export the SC3 inventory.xml file

Fig. 4.1: A Raspberry Pi 3 (left) and a single component passive seismometer (right).

4. If you do not manage to create your own SC3 inventory.xml, download the file from the following link: http://geofon.gfz-potsdam.de/training/inventory/inventory_GE_TST1.xml

4.3 Import the inventory.xml file in your SeisComP3 system

1. Open scconfig by invoking the *scconfig* command on a terminal.
2. Go to the inventory tab by clicking on the icon on the left side.
3. Import your inventory.xml file by clicking on the "import" button. Select "sc3" as format and click on Source to provide the path to the inventory.xml file.
4. Click on the Sync keys button.
5. Move to the Bindings tab by clicking on icon on the left side.
6. Your network and station should appear in the top left panel.
7. Create the bindings for the station as done already in Chapter 3 for the GE network.
8. For your station you will need to create a new seedlink profile and binding for the source (from where you acquire the data and select the appropriate plugin if you do not use slink as acquisition protocol). More about Seedlink, acquisition binding/plugins here: http://www.seiscomp3.org/doc/jakarta/current/apps/seedlink.html#bindings
9. For this particular demo station seedlink can be used for the acquisition. Therefore you only need to add the IP of the server on the station in the chain_plugin, by clicking on the green + button.
10. As this demo station is streaming SH? streams you should be sure to have a global profile with "detecStream = SH" associated with this station.
11. Ctrl+S to save.
12. Go to the System tab by clicking on the icon on the left side.
13. Press Esc to de-select all modules and press "Update Config".

Open SeisComP trace view (*scrttv*) or map view (*scmv*) and if you see your stream acquired then you have successfully configured your station.

CHAPTER

FIVE

COMMONLY USED METADATA FORMATS WITH SC3

In the previous chapter we imported metadata from a data centre to configure the real-time acquisition of the GEOFON network. Now we will introduce the different metadata formats that you can use.

Today there are three common formats to store metadata:

- FDSN StationXML [REF:FIXME]
- SC3 inventory
- Dataless SEED [REF:FIXME] - the old *de facto* standard.

Dataless SEED can be imported to, and exported from, SeisComP if needed.

5.1 SC3 inventory

Due to historical reasons, there are two (equivalent) XML representations of the SC3 inventory: Arclink XML (which pre-dates SC3) and SC3 XML.

When importing metadata into an SC3 system, using either of those guarantees 100% lossless conversion.

5.2 The data model

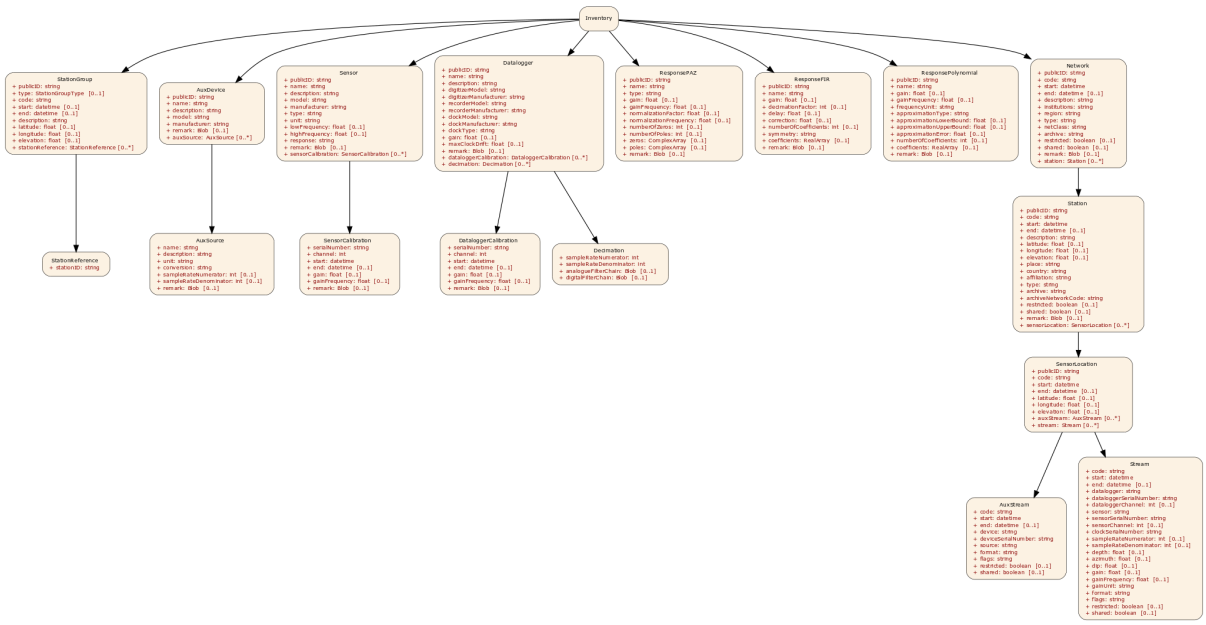


Fig. 5.1: Click on this link (SeisComP documentation) to open the image and be able to zoom in.

FIXME Update link to jakarta e.g.

http://www.seiscomp3.org/doc/jakarta/current/_images/graphviz-8acf18cd62164c67463fa3de918f9587036a1d9a.svg

5.3 Arclink XML example

An Arclink representation of the inventory:

```
<inventory xmlns="http://geofon.gfz-potsdam.de/ns/Inventory/1.0/">
  <network archive="GFZ" code="CX" description="IPOC Seismic Network (Integrated Plate
   boundary Observatory Chile)" end="" institutions="GFZ/IPGP" netClass="p"
   publicID="Network#20130513163602.210354.2" region="Northern Chile" restricted="false"
   shared="true" start="1980-01-01T00:00:00.0000Z" type="VBB">
    <remark/>
    <station affiliation="IPOC" archive="GFZ" archiveNetworkCode="CX" code="PB06"
     country="Chile" description="IPOC Station PB06, Chile" elevation="1440.0" end=""
     latitude="-22.7058" longitude="-69.57188" place="PB06"
     publicID="Station#20130513163602.244857.24" restricted="false" shared="true"
     start="2007-03-04T00:00:00.0000Z" type="">
      <remark/>
      <sensorLocation code="" elevation="1440.0" end="" latitude="-22.7058"
       longitude="-69.57188" publicID="SensorLocation#20130513163602.244886.25"
       start="2007-03-04T00:00:00.0000Z">
        <stream azimuth="0.0" clockSerialNumber="" code="LLZ"
         datalogger="Datalogger#20130513163602.212591.7" dataloggerChannel="0"
         dataloggerSerialNumber="1843" depth="0.0" dip="-90.0" end="" flags="GC"
         format="Steim2" gain="427566.942" gainFrequency="1.0" gainUnit="M/S**2"
         restricted="false" sampleRateDenominator="1" sampleRateNumerator="1"
         sensor="Sensor#20130513163602.219932.14" sensorChannel="0"
         sensorSerialNumber="2555" shared="true" start="2007-03-04T00:00:00.0000Z" />
      </sensorLocation>
    </station>
  </network>
</inventory>
```

5.4 SeisComP XML example

A SC3 representation of inventory:

```
<seiscomp xmlns="http://geofon.gfz-potsdam.de/ns/seiscomp3-schema/0.7" version="0.7">
  <Inventory>
    <network publicID="Network#20130513163602.210354.2" code="CX">
      <start>1980-01-01T00:00:00.0000Z</start>
      <description>IPOC Seismic Network (Integrated Plate boundary Observatory Chile)
      </description>
      <institutions>GFZ/IPGP</institutions>
      <region>Northern Chile</region>
      <type>VBB</type>
      <netClass>p</netClass>
      <archive>GFZ</archive>
      <restricted>false</restricted>
      <shared>true</shared>
      <remark/>
      <station publicID="Station#20130513163602.244857.24" code="PB06"
       archiveNetworkCode="CX">
        <start>2007-03-04T00:00:00.0000Z</start>
        <description>IPOC Station PB06, Chile</description>
        <latitude>-22.7058</latitude>
        <longitude>-69.57188</longitude>
```

```
        <elevation>1440</elevation>
        <place>PB06</place>
        <country>Chile</country>
        <affiliation>IPOC</affiliation>
        <archive>GFZ</archive>
        <restricted>false</restricted>
        <shared>true</shared>
        <remark/>
        <sensorLocation publicID="SensorLocation#20130513163602.244886.25" code="">
          <start>2007-03-04T00:00:00.0000Z</start>
          <latitude>-22.7058</latitude>
          <longitude>-69.57188</longitude>
          <elevation>1440</elevation>
          <stream code="LLZ" datalogger="Datalogger#20130513163602.212591.7"
           sensor="Sensor#20130513163602.219932.14">
            <start>2007-03-04T00:00:00.0000Z</start>
            <dataloggerSerialNumber>1843</dataloggerSerialNumber>
            <dataloggerChannel>0</dataloggerChannel>
            <sensorSerialNumber>2555</sensorSerialNumber>
            <sensorChannel>0</sensorChannel>
            <sampleRateNumerator>1</sampleRateNumerator>
            <sampleRateDenominator>1</sampleRateDenominator>
            <depth>0</depth>
            <azimuth>0</azimuth>
            <dip>-90</dip>
            <gain>427566.942</gain>
            <gainFrequency>1</gainFrequency>
            <gainUnit>M/S**2</gainUnit>
            <format>Steim2</format>
            <flags>GC</flags>
            <restricted>false</restricted>
            <shared>true</shared>
          </stream>
        </sensorLocation>
      </station>
    </network>
  </Inventory>
</seiscomp>
```

5.5 Importing metadata to SC3

It is easiest to use the import function of the scconfig GUI. Alternatively, you can import from the command line:

- From FDSN StationXML:

```
fdsnxml2inv -f station.xml > etc/inventory/mynetwork.xml
```

- From SeisComP XML with filtering:

```
invextr -f --chans 'NE.STA.*' mynetwork.xml > etc/inventory/mynetwork.xml
```

- From Arclink XML:

```
arclink2inv -f inventory.xml >etc/inventory/mynetwork.xml
```

- From a dataless SEED volume:

```
dlsv2inv -f mynetwork.seed > etc/inventory/mynetwork.xml
```

5.6 Things to avoid

- Requesting in *dataless* format from Arclink and importing with dlsv2inv (request inventory and use arclink2inv instead).
- Converting XML to dataless, editing with PDCC, converting dataless back to XML (use invextr or SMP instead).

5.7 How to get inventory

We will request the inventory from all stations belonging to network GE.

5.7.1 Option 1: Using FDSN web services

The FDSN web services are the standard proposed by the FDSN and have been deployed at almost every data centre [1]. One of them is called *fdsnws-station* and is the service to contact to get all information related to stations, sensors, responses, etc.

To get data from the *fdsnws-station* web service you can use any web client (browser or command line). For instance, the *wget* command. The file you will receive will be in StationXML format.

```
$ wget "http://geofon.gfz-potsdam.de/fdsnws/station/1/query?net=GE&level=response" -O ge.xml
```

5.7.2 Option 2: Using fdsnws_fetch

This is described in the chapter *Using fdsnws_fetch*.

5.7.3 Option 3: Using arclink_fetch

arclink_fetch is a command-line client which allows you to send requests (e.g. data, inventory) to Arclink servers. The inventory information you receive will be in *Inventory XML* format.

```
$ echo "1980,1,1,0,0,0 2030,1,1,0,0,0 GE * * *" | arclink_fetch
   -u user@mymailaddress.com -k inv -vvv -o ge.xml
```

5.7.4 Option 4: Using WebDC3

WebDC3 is a graphical interface which allows you not only to send requests to Arclink servers, but also to explore available stations and query event catalogs from different data centres among other possibilities.

You can find detailed information about WebDC3 in the on-line documentation at http://webdc3.readthedocs.io/en/latest/

FIXME This is about event selection!

- Go to http://eida.gfz-potsdam.de/webdc3 with a browser.
- Click on "Explore events" and select a date interval from 24 August 2016 to 25 August 2016 and a minimum magnitude of 6.
- Shift+click on the map to select a square around Europe and then click on "Search".
- Only one event in Central Italy should appear in the list on the right part of the page.
- Click on "Explore stations" and move the slider to select only the year 2016 and only "Public permanent nets" on the Network type list.

[1] International Federation of Digital Seismograph Networks, 2016. "FDSN Web Services", http://www.fdsn.org/webservices/

- Select “by Events” on the “Stations” section to select stations based on their distance related to the selected event.
- Select stations only to a distance from the event less than 15 degrees.
- Click on the BH entry in the list of streams and then “Search”.
- Between 600 and 700 stations should appear on the list below the event.
- Go to the third tab, named “Submit request”.
- Click on “Absolute Mode” for the “Time Window Selection” and select time window from 24-08-2016 to 25-08-2016.
- In the “Request type” section, click on “Metadata (Inventory XML)”
- Enter your email address and click “Review”.
- If everything looks correctly click on “Submit”.
- Go to the fourth tab, called “Download Data”.
- In the “Recent requests” block, click on your request and check its status periodically with “Refresh”
- Display the logs by clicking on the “plus (+) character.
- When it’s ready, click to download the data.

5.7.5 Option 4: Creating your own inventory

If you would like to create you own inventory you may try to use some tools like *SMP*. This is an online tool which you can use at https://test.gempa.de/smp/ (beta version). Before doing so, you will need to create an account at https://seismo.gempa.de/smp/ .

CHAPTER

SIX

IMPORT A MINISEED FILE INTO A LOCAL SDS ARCHIVE

6.1 Download waveforms from a data centre

Some methods to download data are suitable only if data are hosted only at one data centre. For the next examples, we need to know in advance that the data has been archived at GEOFON.

6.1.1 FDSN Dataselect web service using GET method

You can use a browser or the "wget" command line tool to download data from HH channels of station LVC in network GE with location code 10 on a particular time frame.

```
sysop@SC3-VirtualBox:~$ wget "http://geofon.gfz-potsdam.de/fdsnws/dataselect/1/query?
    starttime=2015-02-22T02:30:00&endtime=2015-02-22T07:30:00&net=GE&sta=LVC&loc=10&
    cha=HH*" -O GE.mseed
```

And with another command you can download data from HH channels of all stations in network CX for the same time window.

```
sysop@SC3-VirtualBox:~$ wget "http://geofon.gfz-potsdam.de/fdsnws/dataselect/1/query?
    starttime=2015-02-22T02:30:00&endtime=2015-02-22T07:30:00&net=CX&cha=HH*"
    -O CX.mseed
```

6.1.2 FDSN Dataselect web service using POST method

You can get the same data by creating a plain text file specifying the streams and time windows that you need with the following format in every line:

NN SS LL CC STARTTIME ENDTIME

Here, NN SS LL CC are the network, station, location and channel respectively and STARTTIME and ENDTIME are in ISO8601 format (YYYY-MM-DDTHH:MM:SS).

```
sysop@SC3-VirtualBox:~$ cat post-req.txt
    CX * * HH* 2015-02-22T02:30:00 2015-02-22T07:30:00
    GE LVC 10 HH* 2015-02-22T02:30:00 2015-02-22T07:30:00
sysop@SC3-VirtualBox:~$ wget --post-file=post-req.txt
     "http://geofon.gfz-potsdam.de/fdsnws/dataselect/1/query" -O allData.mseed
    --2015-05-11 11:16:12--  http://geofon.gfz-potsdam.de/fdsnws/dataselect/1/query
    Auflösen des Hostnamen »geofon.gfz-potsdam.de (geofon.gfz-potsdam.de)« 139.17.3.177
    Verbindungsaufbau zu geofon.gfz-potsdam.de (geofon.gfz-potsdam.de)|139.17.3.177|:80
     verbunden.
    HTTP-Anforderung gesendet, warte auf Antwort... 200 OK
    Länge: nicht spezifiziert [application/vnd.fdsn.mseed]
    In »»allData.mseed«« speichern.
        [             <=>
    2015-05-11 11:16:59 (1,87 MB/s) - »allData.mseed« gespeichert [91132928]
```

Note: A complete specification of the FDSN web services can be found at https://www.fdsn.org/webservices/FDSN-WS-Specifications-1.1.pdf

FIXME German!

6.2 Download waveforms distributed at many data centres

For more complex requests, where data is distributed in many data centres, you will need a client to find where the data are hosted and perform the request to the different data centres.

6.2.1 arclink_fetch

As mentioned in the past chapters, *arclink_fetch* is a command line client which allows you to retrieve data and metadata from all data centres taking part of EIDA.

You will need to specify what you want to request in a format like this:

```
$ cat req.txt
2015,2,22,2,30,0 2015,2,22,7,30,0 CX * HH* *
2015,2,22,2,30,0 2015,2,22,7,30,0 GE LVC HH* 10

$ cat req.txt | arclink_fetch -u yourname@domain.com -vvv -o gecx.mseed
```

Note: More detailed information about *arclink_fetch* can be found at https://www.seiscomp3.org/wiki/doc/applications/arclink_fetch .

6.2.2 The WebDC3 portal

In this example, we will download one hour of waveforms from selected stations for a particular time window. Namely, BH channels from all stations in GE and the ones with a distance of less than 15° from an event on August 24th 2016 in Italy.

- Go to http://eida.gfz-potsdam.de/webdc3 with a browser.
- Click on "Explore events" and select a date interval from 24 August-2016 to 25 August 2016 and a minimum magnitude of 6.
- Shift+click on the map to select a square around Europe and then click on "Search".
- Only one event in Central Italy should appear in the list on the right part of the page.
- Click on "Explore stations" and move the slider to select only the year 2016 and only "Public permanent nets" on the Network type list.
- Select "by Events" on the "Stations" section to select stations based on their distance related to the selected event.
- Select stations only to a distance from the event less than 15 degrees.
- Click on the BH entry in the list of streams and then "Search".
- Between 600 and 700 stations should appear on the list below the event.
- Go to the third tab, named "Submit request".
- Select "Relative Mode" to define time windows relative to the estimated P arrival.
- Enter "10" in *Start time* and "50" in *End time* to request a time window of one hour around the event.

- In the "Request type" section, click on "Waveform (Mini-SEED)"
- Enter your email address and click "Review".
- Please note that the time window shown at each line will be different, as thesee are calculated based on the distance from the epicentre.
- If everything looks correctly click on "Submit".
- Go to the fourth tab, called "Download Data".
- In the "Recent requests" block, click on your request and check its status periodically with "Refresh".
- You can see the logs by clicking on the *plus* (+) character.
- When it's ready, download the data. Please, note that there will be one link (Download Volume) for each data centre providing data. You will need to click on all of them.

6.3 Create an SDS structure for your data

Warning: For the next two examples it is important to include the *dot* as a last parameter to the *scart* command.

Create a directory for the archive

```
sysop@SC3-VirtualBox:~$ mkdir -p ~/seiscomp3/var/lib/archive
sysop@SC3-VirtualBox:~$ cd ~/seiscomp3/var/lib/archive
```

And archive all the files which you downloaded:

```
sysop@SC3-VirtualBox:~/seiscomp3/var/lib/archive$ scart -vvvv -I ~/Package-X.mseed .
```

Alternatively, you can do it for the file with all the preloaded data.

```
sysop@SC3-VirtualBox:~/seiscomp3/var/lib/archive$ scart -vvvv -I ~/Downloads/data.mseed .
```

6.3.1 Import the metadata for your stations

- Open *scconfig* and click on "Inventory".
- Select "Import" and browse to the file with the inventory (~/Downloads/inventory.xml) and select the format "arclink".
- Click on OK, wait a couple of seconds, check that the process was successful and close the modal window.
- Go to "System" (second icon in the left column), click on "Update configuration" and restart SeisComP3 (Stop and Start buttons).

CHAPTER

SEVEN

EXCHANGE DATA AND METADATA WITH OTHERS

In this chapter we activate FDSN web services [And Arclink? :FIXME:] to allow waveforms and inventory metadata to be shared with others.

7.1 Check Arclink installation

Connect to your Arclink server through telnet and perform a request with the following commands:

```
telnet localhost 18001
HELLO
USER you@yourdomain
REQUEST waveform
2016,8,24,2,0,0 2016,8,24,2,0,20 GE MATE BHZ .
END
```

(The server responds after each command, with a message such as "OK".) You will receive a number as a response from the last command. Let's suppose that it's 333. Then, continue with the following commands.

```
status 333
```

This shows a small XML document. In the *<volume>* tag are the status and size attributes:

```
status 333
<?xml version="1.0"?>
<arclink>
    <request args="" encrypted="false" error="false" id="333" label="" message="" ready="true" si
        <volume dcid="MYDC" encrypted="false" id="MYDC-73088822" message="" size="36864" status="
            <line content="2016,8,24,2,0,0 2016,8,24,2,0,30 GE MATE BHZ ." message="" size="15872
        </volume>
    </request>
</arclink>
END
```

Keep asking for the status until you can see that it's OK. Next to the status, the final size of your request will be shown, in case you want to download it. Use the following command (this is ''not" recommended; it will dump binary SEED data directly to your terminal):

```
DOWNLOAD 333
BYE
```

7.2 Configure FDSN web services in your SC3

- Open *scconfig*.
- Click on the "Modules" icon and go to the "global" module.
- Look for the "database" section and complete the following:

```
type=mysql
parameters=sysop:sysop@localhost/seiscomp3
```

- Press Ctrl+S to save the configuration.
- Go to the "fdsnws" module in the tree on the left. Then, go to the "global" section and the "recordstream" subsection and complete with the following:

```
service=sdsarchive
source=/home/sysop/seiscomp3/var/lib/archive
```

- Press Ctrl+S to save the configuration.
- Click to the "System" icon, click on "Update configuration" and restart SeisComP3 (Stop and Start buttons).

7.3 Send requests to the web services

7.3.1 Metadata

- Open a browser and go to http://localhost:8080/fdsnws/station/1/query?level=station

Basically, what you are requesting here is a list of all the stations configured in your system using the SeisComP3 implementation of the FDSN web services.

You should see the whole GE network and the stations around the event in Italy. With this test you verify that the inventory is apparently correct AND that you are able to share this data with others via FDSN web services, in the same way as data centres do.

7.3.2 Waveforms

- You can do the same for the waveforms that you have imported.
- In the browser go to http://localhost:8080/fdsnws/dataselect/1/query?starttime=2016-08-24T02:00:00&endtime=2016-08-24T02:10:00&net=GE
- You requested all the waveforms from the GE network from 2016-08-24T02:00:00 to 2016-08-24T02:10:00.

Now you can use clients to work with your data. For instance, *scolv*. Remember to switch in *scolv* to "combined" (combined://localhost:18000;localhost:18001) to load the waveforms from the archive.

CHAPTER

EIGHT

USING FDSNWS_FETCH

8.1 Introduction

fdsnws_fetch is a Python script that simplifies downloading data and metadata from FDSN web services. It supports the following notable features:

- Routing the request to datacenters that archive respective stations/channels.
- Merging results from multiple datacenters into one MiniSEED, XML or text file.
- Authentication with username and password or with a token.

8.2 Installation

fdsnws_fetch is a single script without any special dependencies. It is compatible with Python 2 (at least 2.6) and Python 3.

Note: The following examples assume that the script can be found in PATH and execute bit added (chmod a+x fdsnws_fetch).

8.3 Usage examples

Request 60 minutes of the `"LHZ"` channel of EIDA stations starting with `"A"` for a seismic event around 2010-02-27 07:00 (UTC). Optionally add `"-v"` for verbosity. Resulting Mini-SEED data will be written to file `"data.mseed"`.

```
$ fdsnws_fetch.py -N "*" -S "A*" -L "*" -C "LHZ" \
  -s "2010-02-27T07:00:00Z" -e "2010-02-27T08:00:00Z" -v -o data.mseed
```

StationXML metadata for the above request can be requested using the following command:

```
$ fdsnws_fetch.py -N "*" -S "A*" -L "*" -C "LHZ" \
  -s "2010-02-27T07:00:00Z" -e "2010-02-27T08:00:00Z" \
  -y station -q level=response -v -o station.xml
```

Multiple query parameters can be used:

```
$ fdsnws_fetch.py -N "*" -S "*" -L "*" -C "*" \
  -s "2010-02-27T07:00:00Z" -e "2010-02-27T08:00:00Z" \
  -y station -q format=text -q level=channel \
  -q latitude=20 -q longitude=-150 -q maxradius=15 -v -o station.txt
```

Bulk requests can be made in ArcLink (-f), breq_fast (-b) or native FDSNWS POST (-p) format. Query parameters should not be included in the request file, but specified on the command line.

```
$ fdsnws_fetch.py -p request.txt -y station -q level=channel -v -o station.xml
```

The list of all command-line options can be obtained with

```
$ fdsnws_fetch.py --help
```

CHAPTER

NINE

IMPORT DATA AND METADATA FROM EVENTS TO SC3

This chapter brings together some of the different topics which have been seen previously. We start with information about an event and will go through the whole process until you can use the SeisComP3 GUIs to work on the traces.

Before starting on a particular event, you should delete your current inventory and bindings. (You may back them up first, by copying seiscomp3/etc/inventory and seiscomp3/etc/key .)

```
cd ~/seiscomp3/etc
rm inventory/*.xml
seiscomp update-config
```

The last line is needed to ensure inventory objects are removed from the SC3 database.

9.1 Exercise 1 - Central Italy

In the morning of August 24th 2016 there was a large earthquake in central Italy.

1. Download inventory from all stations with BH streams from networks MN, IV and GE (which had stations in the area) operating on this day. The *-y station -q level=response* options are used to request inventory which can be imported into SC3.

```
$ ./fdsnws_fetch.py -N "MN,IV,GE" -C "BH*" -y station -q level=response \
 -s "2016-08-24T01:30:00Z" -e "2016-08-24T03:00:00Z" -v -o mnivge.xml
```

   Note: In case of a slow connection or large processing time, the dataset can be downloaded from http://geofon.gfz-potsdam.de/jakarta-2016/mnivge.xml .

2. Download 90 minutes of all BH streams from networks MN, IV and GE related to the event in central Italy on August 24th 2016 (http://geofon.gfz-potsdam.de/eqinfo/event.php?id=gfz2016qphx).

```
$ ./fdsnws_fetch.py -N "MN,IV,GE" -C "BH*" -s "2016-08-24T01:30:00Z" \
-e "2016-08-24T03:00:00Z" -v -o mnivge.mseed
```

3. Archive the data by means of *scart*.

```
$ cd ~/seiscomp3/var/lib/archive
$ scart -vvvv -I ~/mnivge.mseed .
```

4. Open *scolv* and configure the recordstream to read the data from your local disk (sdsarchive:///home/sysop/seiscomp3/var/lib/archive). Create an artificial origin using the details of the event from the web page at GEOFON:

```
$ scolv -I sdsarchive:///home/sysop/seiscomp3/var/lib/archive
```

Warning: Recordstream at *scolv* can be configured with *arclink* or *sdsarchive*. With *arclink*, *scolv* contacts an Arclink server—either your own local one, or at a remote site. With *sdsarchive*, *scolv* looks for data in a specially structured local directory (an "SDS archive") which contains data in a separate file for each day and stream.

9.2 Exercise 2 - Myanmar

We now consider another large event later on the same day, in Myanmar. In the above case, the standard EIDA routing service was used. We can also specify a different routing service, for example, one providing an extended routing service that includes the IRIS DMC, by changing the URL with the '-u' option:

1. Download inventory from all stations from networks II, IU, IC and GE with BH streams operating on August 24th 2016.:

```
$ ./fdsnws_fetch.py -u "http://rz-vm258.gfz-potsdam.de/eidaws/routing/1/" \
  -N "II,IC,IU,GE" -C "BH*" -L "00,--" -y station -q level=response \
  -s "2016-08-24T10:30:00Z" -e "2016-08-24T12:00:00Z" -v -o event-20160824.xml
getting routes from http://rz-vm258.gfz-potsdam.de/eidaws/routing/1/query?n...
getting data from http://services.iris.edu/fdsnws/station/1/query
getting data from http://geofon.gfz-potsdam.de/fdsnws/station/1/query
got 3792016 bytes (application/xml) from http://geofon.gfz-potsdam.de/fdsnw...
got 4919911 bytes (application/xml) from http://services.iris.edu/fdsnws/st...
got 7028476 bytes (application/xml) from http://services.iris.edu/fdsnws/s...
```

   Observe that inventory is requested from several data centres, each of which have some part of the requested metadata.

   Note: In case of a slow connection or large processing time, the dataset can be downloaded from http://geofon.gfz-potsdam.de/training/resources/event-20160824.xml (5.4MB) or http://geofon.gfz-potsdam.de/jakarta-2016/iiiciuge.xml

2. Download 90 minutes of all BH streams from the same networks from around the time of the event (10:34Z) in Myanmar on August 24th 2016 (http://geofon.gfz-potsdam.de/eqinfo/event.php?id=gfz2016qpzr).

```
$ ./fdsnws_fetch.py -u "http://rz-vm258.gfz-potsdam.de/eidaws/routing/1/" \
  -N "II,IC,IU,GE" -C "BH*" -L "00,--" -s "2016-08-24T10:30:00Z" \
  -e "2016-08-24T12:00:00Z" -v -o iiiciuge.mseed
getting routes from http://rz-vm258.gfz-potsdam.de/eidaws/routing/1/query?...
getting data from http://services.iris.edu/fdsnws/station/1/query
getting data from http://geofon.gfz-potsdam.de/fdsnws/station/1/query
got 22908928 bytes (application/vnd.fdsn.mseed) from http://geofon.gfz-pot...
got 68535808 bytes (application/vnd.fdsn.mseed) from http://services.iris....
```

3. Import the metadata using *scconfig*. Clean your inventory first, as above.

   Then convert the new inventory from FDSN Station XML and import it. This may be done in the GUI using Import on the Inventory tab. You may instead load inventory manually by using *import_inv* and *scinv* directly:

```
$ ~/seiscomp3/bin/seiscomp exec import_inv help formats
sc3
dlsv
key
arclink
nettab
fdsnxml
tab
```

   In the present case, we need to specify that our inventory format is *fdsnxml*:

```
$ ~/seiscomp3/bin/seiscomp exec import_inv fdsnxml \
     event-20160413.xml new.xml
$ mv new.xml ~/seiscomp3/etc/inventory/
$ ~/seiscomp3/bin/seiscomp exec scinv sync
WARNING: /home/sysop/seiscomp3/etc/inventory/README ignored: wrong extension
Parsing /home/sysop/seiscomp3/etc/inventory/new.xml ... done
Merging inventory ... done
Synchronising inventory ... done
Removing remaining objects ... done
3367 notifiers available

Sending notifiers: 2%
Sending notifiers: 5%
[..]
Sending notifiers: 100%
Added 151 new key file(s) and no old key file removed
Sending notifiers: 11%
```

This reads all inventory files found in ~/seiscomp3/etc/inventory and replaces what is in the database. The warning message may be ignored, or just delete the README file.

4. Add the data to your own archive by means of *scart*.

```
$ cd ~/seiscomp3/var/lib/archive
$ scart -vvvv -I ~/iiiciuge.mseed .
Archive: ./
Mode: IMPORT
12:37:34 [debug/RecordStream] trying to open stream file://event-20160413.seed
GE.APE..BHE 2016-04-13T13:49:58.695Z 2016/GE/APE/BHE.D/GE.APE..BHE.D.2016.104
GE.APE..BHE 2016-04-13T13:50:25.995Z 2016/GE/APE/BHE.D/GE.APE..BHE.D.2016.104
[..]
12:37:42 [info/RecordInput] End of stream detected
```

Note the final *dot* as parameter to the *scart* command, to create the archive in the current directory.

This may take a few minutes when there are many streams to process. Afterwards you will see that data files have been added in your SC3 archive directory. e.g. ~/seiscomp3/var/lib/archive/2016:

```
ls 2016/*/*/*.D/*HZ.D.2016.237 | head
```

(Note that 24 August is the 237th day of 2016.)

Take care to only run *scart* once with a given set of streams. The second time you run it, waveforms will be added to the end of those already existing in your SDS. This may be confusing.

5. Open *scolv* and configure the recordstream to read the data from your local disk (sdsarchive:///home/sysop/seiscomp3/var/lib/archive). Create an artificial origin with the details of the event from the web page at GEOFON [1] .

```
$ seiscomp check spread scmaster
$ scolv -I sdsarchive:///home/sysop/seiscomp3/var/lib/archive
```

Right click on the map in the Location tab to create an origin. Then open the picker. Add all stations up to 60 degrees. You should see traces from many, but not all, stations. (Not all stations will have been operating at the time of the event.)

9.3 Other Myanmar events

It is handy to set a few shell variables, and adjust the values of '${start}' and '${end}' below as required. If you are using *bash*:

[1] GFZ event gfz2016qpzr at 2016-08-24 10:34:55.4 UTC; lat: 20.92°N lon: 94.64°E ; depth: 91 km

```
.. code-block:: bash
```

$ serviceurl="http://rz-vm258.gfz-potsdam.de/eidaws/routing/1/" $ start="2016-04-13T13:50:00Z" $ end="2016-04-13T14:50:00"

- Repeat the above for the 2016-04-13 13:55 M6.9 Myanmar-India Border Region event, GFZ event id gfz2016hhgj [2]

  Use with networks MY, RM, TM, IU, II, GE, 60 minutes, starting at 2016-04-13T13:50:00Z.

Note: Backup files: http://geofon.gfz-potsdam.de/training/resources/event-20160413.xml and

---

- Now add the IC (New China Digital Seismograph Network) network, which provides delayed data.
  - scart will add this data [4.5MB] as before:

```
./fdsnws_fetch.py -u "${serviceurl}" \
  -N IC -C "BH*" \
  -s "${start}" -e "${end}" -v -o event-20160413_IC.seed
scart -v -I event-20160413_IC.seed
```

  - adding inventory is easy with *scconfig*. But if you do this manually, use the *merge* option to *scinv*, not *sync*.

- There is no MM data (Myanmar National Seismic Network) for 2016-04-13, but there is data for the more recent event. These have stream code HHE, HHN, HHZ. So now add the MM data for 2016-08-24. [32MB]:

```
./fdsnws_fetch.py -u "${serviceurl}" -N MM -C "HH*" \
    -s "${start}" -e "${end}" -v -o event-20160824_MM.seed
seiscomp exec scart -v -I event-20160824_MM.seed
```

  You can also get IN (National Seismic Network of India) HH streams the same way. [resources/event-20160824_MMIN.seed, 43MB;

  resources/event-20160824_MYRMTM.seed, 23MB.]

- Repeat the above with networks MY, RM, TM, IC, IU, II, GE, for the event on 3 January 2016. [3]
- Repeat the above for the event on 11 November 2012. [4]

[2] GFZ event gfz2016hhgj at 2016-04-13 13:55:17.8 UTC; epicenter: 94.83°E 23.08°N; depth: 136 km.
[3] GFZ event gfz2016afks at 2016-01-03 23:05:20.0 UTC; magnitude: 6.7 (Mw); epicenter: 93.58°E 24.78°N; depth: 37 km
[4] GFZ event gfz2012wdpw at 2012-11-11 01:12:40.0 UTC; magnitude: 6.8 (Mw); epicenter: 95.87°E 22.92°N; depth: 15 km

CHAPTER

TEN

OFFLINE DATA PLAYBACKS

(This chapter has been removed to Appendix *Offline Data Playbacks*.)

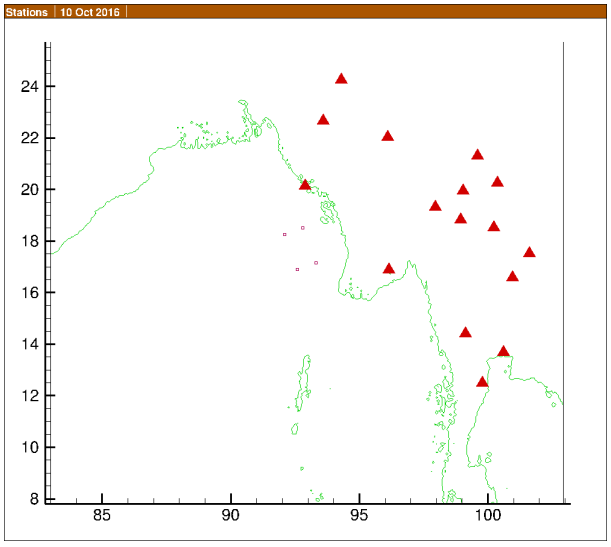
CHAPTER

ELEVEN

EVENT SIMULATION USING SYNTHETIC WAVEFORMS

It is possible to generate mini-SEED data from a simulation of a seismic event. For a given set of hypothetical event parameters, this is quite quick, if pre-computed Greens functions are available.

In this exercise, we use synthetic waveforms prepared by Dr Andrey Babyenko (GFZ Potsdam) corresponding to a large event in the Bay of Bengal, off the coast of Myanmar. Waveforms are prepared for 17 stations in Myanmar and Thailand.



The outline is:

1. Given a sorted mseed data file, extract to local SDS archive.
2. Locate as usual, either
    - by automatic playback, or
    - manually, by creating an artificial origin and loading waveforms in the picker.

In this introduction we only describe the second approach to location.

11.1 Extract sorted mini-SEED to local archive

Download the **.mseed* files from the GEOFON training web site:

```
wget http://geofon.gfz-potsdam.de/training/resources/sc01.mseed
wget http://geofon.gfz-potsdam.de/training/resources/sc02.mseed
```

To avoid conflict with existing files in your standard SC3 archive (normally ~/seiscomp3/var/lib/archive) we will create a second SDS archive. We extract mini-SEED into this new archive:

```
cd ~/seiscomp3/var/lib
mkdir synth
cd synth
~/seiscomp3/bin/seiscomp exec scart -v -I sc01.mseed . >scart.out 2>&1
~/seiscomp3/bin/seiscomp exec scart -v -I sc02.mseed . >scart.out 2>&1
```

Don't forget the dot ('.') at the end of the scart command! This causes scart to extract to the current working directory. Extraction should only take a few seconds. You will now have data in your archive directory e.g. ~/seiscomp3/var/lib/synth:

```
du -sh 2016
1.5M    2016/
ls 2016
IU  MM  RM  TM
```

11.2 Myanmar waveform playback reconfiguration

Ensure inventory contains the BH channels and their responses. (*scinv ls > ~/scinv.out ; sed -n -e '/network MM/,/network /p' ~/scinv.out | more* should show *channel BHE* etc.)

If needed:

```
mv myanmar_MM_BH.xml ~/seiscomp3/etc/inventory
```

and use scconfig to sync inventory.

Adjust bindings:

- Create a global:MM profile. This lets you more easily switch between normal settings, using HH channels, and playback settings, using BH channels. Set *detecStream = BH*.
- Apply this profile to all MM stations. In scconfig, use CTRL+S to save.
- seiscomp update-config

To return to normal settings, open the global:MM profile, or edit ~/seiscomp3/etc/key/global/profile_MM. Change *detecStream* back to HH, and save. Do *seiscomp update-config ; seiscomp restart scmaster*.

11.3 Manual review

- Start scolv, but with the '-I' option telling it to use your new SDS archive as the record stream for obtaining waveforms:

```
scolv -I sdsarchive:///home/sysop/seiscomp3/var/lib/synth -u synscolv
```

- Create an artifical origin:
  - set origin time to 1 October 2016, 00:00:00
  - set epicentre to 17N, 92E, depth 10 km.
- Open the picker
  - pick the first few stations.
  - close the picker with the red button in the top right
- Relocate. Note the location and residuals.
- Pick additional stations, and return to the main scolv window.
- Use the "Compute magnitudes" button to tell SeisComP to estimate a variety of magnitudes using this origin. Visit the Magnitudes tab to see the different magnitude estimates.

- Click “Confirm” when you are happy with the solution.

The last step writes the event to the database. Next time you open scolv, you can go to the date of the event and refine your solution as necessary.

11.4 Automatic location

There are two sorts of automated playbacks, differing in whether the SC3 database is involved.

For an ‘’online” or ‘’waveform” playback, the database is connected as usual. Simulated objects (events, origins, picks) will all be inserted into the database. This can lead to confusion. However, this can be useful for watching the event unfold in the GUIs (scrttv, scmv, etc.)

The steps are:

1. Configure *seedlink* to work with a special file, a FIFO (first in, first out). The *seedlink* process reads from this, and another program, *msrtsimul* writes to it, reading from a sorted mini-SEED file. All processing continues as usual. The waveforms are stamped with the current time, instead of using the time at which they were recorded.

   In scconfig, under Modules > seedlink: check “msrtsimul”. Save with CTRL+S. Under System > Update configuration.

2. Stop archiving (otherwise you will have copies of the old waveforms in your archive, but at the current time). Restart Seedlink.

```
seiscomp stop slarchive
seiscomp disable slarchive
seiscomp restart seedlink
```

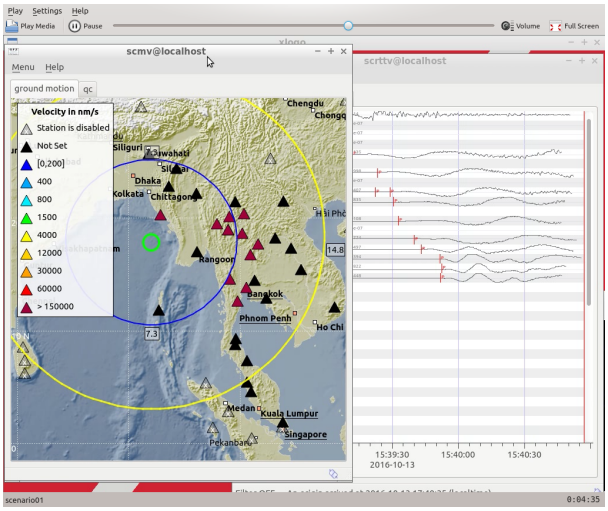
   If you are watching with *scrttv*, you will see waveforms stop. This is expected.

3. Feed in sorted mini-SEED:

```
msrtsimul file.mseed
```

   You can try using the ‘–speed 1.5’ and ‘–jump 2’ options, to make the playback run a little faster, but this is not recommended. Some aspects of locating appear to get a little confused at speed > 1.

4. Watch the show in *scrttv*/*scmv*. Once the event is located, you can see it in *scolv* too.



Screen shot from an online playback. On the left, *scolv* shows that a number of stations have detected a strong signal (dark red triangles). This has been automatically located, with the epicentre in the green circle. Yellow and blue circles show the expanding P and S wavefronts at this instant. There was no synthetic data available for stations shown by black triangles. On the right, *scrttv* shows waveforms in time. Red lines show automatic picks by *scautopick*.

For offline playback, see the *Offline Data Playbacks* chapter.

11.4.1 Production notes

We were given 400 seconds of simulated data. With 3 components, at 20 sps = 24000 samples per station, so this is just a few KB per station. After scart, see about 80-90 KB per station for the 17 stations in sc01.zip; files are for DOY 275 = 2016-10-01. Looks like 00:00:00; 400 seconds later is 00:06:40.

CHAPTER

TWELVE

OFFLINE DATA PLAYBACKS

Playbacks are an important way of testing network configuration (choice of stations and streams used) and the SeisComp settings used for locating events (scautopick and scevent parameters).

12.1 Basic configuration using scconfig

For a playback, you need

1. stations with inventory in the database
2. station configuration via bindings
3. recorded waveforms in an SDS archive.

If you already have the first two of these, you may skip ahead to *Download waveforms from your local archive* below.

12.1.1 Set up SeisComP with CX + GE networks

For this playback we will pick on 100 Hz (HH*) streams from stations in the GE and CX networks. Some of these stations use location code "10" for HH streams. The SC3 system needs to know which stream to work with for each station. In scconfig go to "Bindings". Create profiles in global:

- global/streams
- global/streams_10

Set detecStream=HH in both. Leave detecLocid empty in the first, and set it to "10" in the second. Bind both profiles to networks CX and GE.

Next we need to configure the picker. We start with a default configuration, which is suitable for teleseismic monitoring.

Add another profile:

- scautopick/teleseismic

No further configuration, just use the defaults. Bind the scautopick/teleseismic profile to networks CX and GE, save the configuration and update the configuration in the database (in scconfig: System -> Update configuration)

At this point you are ready to run the playback as described below.

12.2 Download waveforms from your local archive

Create a sorted MiniSEED file from data you already have in your local data archive under *$HOME/seiscomp3/var/lib/archive*

```
$HOME/seiscomp3/bin/seiscomp exec scart -dsE -t
  "2015-02-22 00:00~2015-02-22 23:59:59.999" $HOME/seiscomp3/var/lib/archive >
  sorted.mseed
```

The times here are the start and end times to be included in the sorted mini-SEED file, called sorted.mseed here. Note the time format has a blank space, not a 'T', and a tilde ('~') separates the start and end times.

There are helpful options to *scart* which allow you to restrict the networks/channels included.

You will have to remove stations which are not present in your inventory, or add them to your inventory.

For the Myanmar events:

12.3 Run playback script

The playback.sh script is available in the SC3 wiki:

Wiki page: http://www.seiscomp3.org/wiki/recipes/playbacks/offline/messaging

Direct download: http://www.seiscomp3.org/raw-attachment/wiki/recipes/playbacks/offline/messaging/playback.sh

Before running the playback script, you should (but technically don't have to) disable database writes in scmaster. Stop the SC3 system and edit (create) the file $HOME/.seiscomp3/scmaster.cfg as follows:

```
plugins = ""
```

This tells scmaster not to load any database back ends (normally mysql) and, therefore, no database writes will take place. This has two advantages:

- there is no bottleneck due to database I/O latency,
- you can run the playback as many times as you like without objects colliding in the database.

Both are important considerations for an offline playback. Make sure that the script is executable (*chmod +x playback.sh*), and that scmaster is running (*~/seiscomp3/bin/seiscomp start spread scmaster*).

To run the playback, invoke the script:

```
$HOME/seiscomp3/bin/seiscomp exec ./playback.sh sorted.mseed out.xml
```

The results are written to out.xml. This should take no more than a few seconds.

To visualize the results, you need to have inventory information available, too. Dump it from your local SC3 installation using:

```
$HOME/seiscomp3/bin/seiscomp exec scxmldump -d mysql://sysop:sysop@localhost/seiscomp3
  --debug --inventory -o inventory.xml
```

Then you can invoke scolv:

```
$HOME/seiscomp3/bin/seiscomp exec scolv -I "sdsarchive://$HOME/arcSULU" -u ""
  --inventory-db inventory.xml  --offline --debug
```

And from there you select from the menu File...Open and load out.xml

12.4 Change some settings for regional monitoring

After you are done with the first playback using teleseismic parameters, you may want to change some parameters.

Before doing so, remember that for the playback we previously deactivated database writes in scmaster. If we continue with this setting, the changes in the configuration we are going to make would have no effect, because scmaster would not write them to database. Therefore, we now need to reverse that setting by commenting out this line in $HOME/.seiscomp3/scmaster.cfg:

```
#plugins = ""
```

Stop the SeisComP system and restart it for scmaster to adopt the new setting. Then continue with the configuration as follows.

We cannot show all possibilities here, but we will perform a simple configuration for a local to near-regional monitoring in northern Chile using the CX network. For regional monitoring and small earthquakes the preferred filtering is not around 1 Hz as for teleseismic monitoring, but using higher frequencies. Let's say, frequency band 2-8 Hz (you may want to change that for your network). To do that we create a new profile scautopick/regional in which we adopt all default settings except detecFilter, which we change to

```
RMHP(10)>>ITAPER(10)>>BW(4,2,8)>>STALTA(1,20)
```

This defines a filter chain used in the picking. RMHP and ITAPER are there to properly initialize the stream. BW is a Butterworth bandpass; we choose 4th order from 2-8 Hz. STALTA is a pretty normal STA/LTA filter using an STA window of 1 s and LTA window of 20 s.

Save configuration and update configuration. Re-run playback as described. This should now have produces many more events than before, because of the improved filter settings.

12.5 Save results to SC3 database permanently - and work with them

After playing around with different settings and discovering what works best for your network, you may want to process large amounts of data. You probably want to store the (hopefully!) many events to a SC3 database for further use.

Save event informations from XML file to SC3 database:

```
scdb -d mysql://sysop:sysop@localhost/seiscomp3 -i out.xml
```

Once the events are in the database, you can use tools like scevtls, scxmldump or scbulletin.

```
evt=gfz2015drlk
scbulletin -d mysql://sysop:sysop@localhost/seiscomp3 -E $evt -3
```

Dump event from database to XML:

```
evt=gfz2015drlk
scxmldump -d mysql://sysop:sysop@localhost/seiscomp3 -E $evt --with-picks
  --with-amplitudes --with-focal-mechanisms --with-magnitudes --all-magnitudes
  --formatted --output $evt.xml
```

Convert to QuakeML:

```
sccnv -f -i $evt.xml -o qml1.2rt:$evt.quakeml
```

CHAPTER

THIRTEEN

DOWNLOAD OF RESOURCES

- **VirtualBox download (5.0.24 and 5.0.26)**
  - Windows (5.0.26)
  - Windows (5.0.24)
  - OS X (5.0.26)
  - OS X (5.0.24)
- **VirtualBox Image download**
  - **Myanmar 2016:** LUbuntu 16.04 64 bit with SeisComP3 installed
  - **Trieste 2016:** LUbuntu 16.04 64 bit with SeisComP3 installed
- **SeisComP3 binaries download** [1]
  - Ubuntu 16.04 (and Mint 18) 64 bit
  - Ubuntu 16.04 (and Mint 18) 32 bit
  - Ubuntu 14.04 (and Mint 17) 64 bit
  - Ubuntu 14.04 (and Mint 17) 32 bit
- SeisComP3 maps
- SeisComp3 documentation
- **Data from the event in Central Italy (24.08.2016)**
  - Pre-assembled dataset
- **Metadata**
  - Pre-assembled dataset

[1] For other Linux distributions see the SeisComP3 download page (http://www.seiscomp3.org/downloader).

CHAPTER

FOURTEEN

ADDITIONAL READING AND USEFUL LINKS

- SeisComP3 documentation (current Jakarta release) http://www.seiscomp3.org/doc/jakarta/current/
- SeisComp3 project https://www.seiscomp3.org/
- The GEOFON program http://geofon.gfz-potsdam.de/
- The European Integrated Data Archive (EIDA) http://www.orfeus-eu.org/eida/
- GEMPA GmbH http://www.gempa.de/
- GEMPA Station Management Portal https://seismo.gempa.de/smp/login/?next=/smp/
- Playbacks http://www.seiscomp3.org/attachment/wiki/SC3UG2013/programme/sc3playback.pdf