NERA

Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation

Report

Implementation

Activity:	*JRA2: Tools for real time seismology, acquisition and mining*
Activity number:	*D12.7*
Deliverable:	*Toolbox 7: Implementation*
Deliverable number:	*D12.7*
Responsible activity leader:	*Alberto Michelini*
Responsible participant:	*INGV*
Author:	*Alberto Michelini*

Seventh Framework Programme
EC project number: 262330

Summary

This report addresses the implementation of the software developed in this WP12 – tools for real time seismology, acquisition and mining. It is organized according to the different categories of software packages that have been implemented in this WP. Following what cartoon diagram of Figure 1, they include:

- Input waveforms
- Earthquake Detection/Location
- Earthquake Size/Mechanism
- Fault finiteness
- Strong motion shaking

Additional in collaboration with NA2 we developed the Quality Control package.

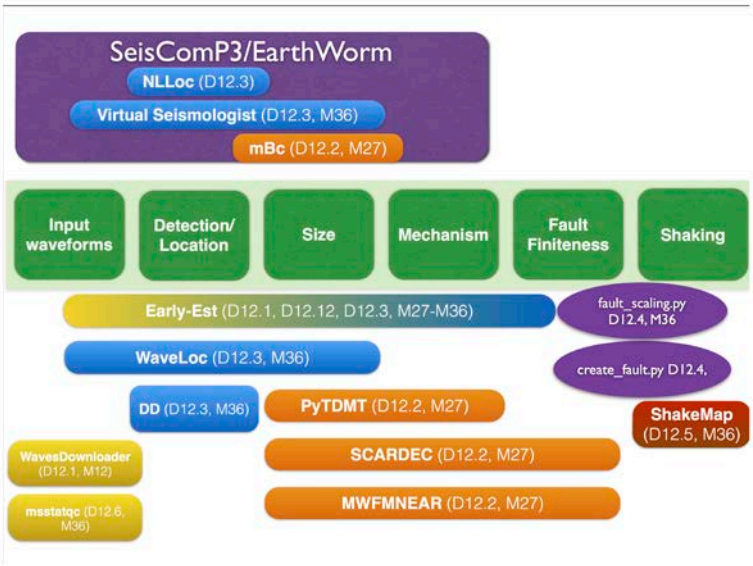

Figure 1. Simplified diagram showing the software implemented in JRA2 and the associated deliverable. The D12.6 deliverable corresponds to utility software shown in the yellow color to the bottom left.

All software is being described on the NERA web site (www.nera-eu.org). This site will be accessible for the next two years, while the relevant links will move to established and maintained sites, such as www.orfeus-eu.org, www.opbspy.org and www.seiscomp3.org.

Input waveforms

These can be obtained in various manners both in streaming using seedlink protocol data connections and off line using various tools. In the context of the WP, it has been developed the **Wavesdownloader** broker program that selects and downloads and performs preprocessing of waveforms data from EIDA and IRIS data centers.

Available at: https://github.com/fabriziobernardi/wavesdownloader
Developer: Fabrizio Bernardi (INGV)
Listed among the use cases/applications on: https://github.com/obspy/obspy/wiki

Earthquake Detection / Location

Virtual Seismologist Earthquake Early Warning methodology

The Virtual Seismologist (VS) method is a Bayesian approach to earthquake early warning (EEW) that estimates earthquake magnitude, location, and the distribution of peak ground shaking using observed picks and ground motion amplitudes, predefined prior information, and envelope attenuation relationships.

Available at: http://www.seismo.ethz.ch/research/groups/alrt/projects/vs/index
Developer: Georgia Cua (ETHZ)
Implemented in SeisComP3 (SC3)
Implemented and tested by
- SED, Switzerland
- NIED, Romania
- NOA, Greece
- U. Patras, Greece
- U. Thessaloniki, Greece
- KOERI, Turkey
- IMO, Iceland
- GNS, New Zealand

Waveloc

WaveLoc performs earthquake detection and location of seismic phenomena by exploiting the waveform as a whole rather than the arrival picks. Adoption of this software can be indicated for the analysis of large data volumes of seismic data.

Available at: http://amaggi.github.io/waveloc/
Developer: Alessia Maggi and Alberto Michelini
Listed among the use cases/applications on: https://github.com/obspy/obspy/wiki

Early-Est

Very rapid calculation of mb, Mwp, Mwpd, and source duration from broadband seismograms at global scale obtained through real-time seedling connections.

Available upon request (Anthony Lomax/Alberto Michelini)
Developer: Anthony Lomax
Implemented by
- INGV, Italy (http://early-est.rm.ingv.it)
- NIEP, Romania (tbd)
- NOA, Greece (http://icp.gein.noa.gr/early-rtm/warning.html)
- KOERI, Turkey (tbd)
- KNMI (http://www.orfeus-eu.org/early-est)

Relative Relocation Toolbox

Available upon request (Andreas Rietbrock)

Earthquake Size / Mechanism

mBc

Calculation of mBc magnitude for large earthquakes in real-time.
Available at: https://github.com/SeisComP3/NERA
Developer: Javier Quinteros (javier@gfz-potsdam.de) and Joachim Saul (saul@gfz-potsdam.de)
Implemented in SeisComP3 (SC3)
Implemented and being tested at GEOFON - GFZ (Germany) (http://geofon.gfz-potsdam.de)

PyTDMT

Moment tensor calculation at regional scale.
Available at: https://github.com/fabriziobernardi/pydmt/blob/master/README_pytdmt.md
Developer: Fabrizio Bernardi
Listed among the use cases/applications on: https://github.com/obspy/obspy/wiki

SCARDEC

Very rapid calculation of source-time function and moment tensor.
Available upon request (Martin Valle)
Operating at: Geoscope (France) http://geoscope.ipgp.fr/index.php/en/
More information file://localhost/at http/::geoscope.ipgp.fr:index.php:en:catalog:earthquake-description%3Fseis=usb000sp80

MWFMNEAR

Integrated package for the rapid and automated determination of earthquake source parameters using near source records.
Available upon request (Bertrand Delouis, delouis@geoazur.unice.fr)
Developer: Bertrand Delouis
Implemented by
NOA, Greece (http://icp.gein.noa.gr/early-rtm/warning.html)
GeoAzur (http://www.geoazur.net/sismoazur)

Fault finiteness

Scripts for fault definition available upon request (Alberto Michelini, alberto.michelini@ingv.it)
Implemented at INGV

Strong motion shaking

Shakemap

Shakemaps, relevant to estimate and publicize rapidly the observed strong motion near the epicentral area of an earthquake, has been originally developed by the USGS:

http://earthquake.usgs.gov/earthquakes/shakemap/

Available at: https://vault.gps.caltech.edu/repos/products/shakemap/tags/release-3.5

To maintain an international standard of the shakemaps we have chosen to adapt the USGS software for local (national) implementation. However, this requires local adaptation of the software and relevant regional ground motion prediction equations. This has been done within this project in at least **4** countries

Implemented by:

INGV (http://shakemap.rm.ingv.it/shake/index.html)
SED (http://www.seismo.ethz.ch/prod/shakemaps/index_EN)
NIEP (http://atlas.infp.ro/~shake/shakemap/)
NOA (http://hydra2.gein.noa.gr/shakemaps/archive/)

Quality Control

Quality Control is an integrated part of handling and managing data, therefore JRA2 collaborated with NA2 in developing the Quality Control software. Thus a joint JRA2/ NA2 QC software package was developed.

Available at: http://www.orfeus-eu.org/man/msstatqc.html
Developer: Reinoud Sleeman
Implemented by
ORFEUS/ODC, Netherlands (http://www.orfeus-eu.org/man/odcws_wfmetadataselect.html)

Conclusions

Overall most software has been implemented and made available and tested in various centers. The software is currently in routine operation in a number of observatories or added to software libraries used by the research community.

To ensure sustainability, most of the software has been implemented either within the ObsPy community (www.obspy.org) or the SeisComP3 community (www.seiscomp3.org). Other software is maintained by network operators like (ETHZ, INGV, ODC, …) and made publicly available through the (cited) websites.