

RapidSeis:

a NERIES spin-off pilot project

Introduction

The objective of this six-month pilot project was to provide a simplified system to perform analysis of seismic waveform data through a web browser. The specific aims were that no data or application be downloaded to the user's computer, for the user to create algorithms to customise the analysis and to allow sharing of algorithms within the seismological community.

The project was funded by JISC who provided partial support for one of the researchers and allowed the three teams based at the University of Liverpool, ORFEUS and the UK National e-Science Centre in Edinburgh to meet regularly. The project culminated in a two day RapidSeis Workshop held at Liverpool in November 2009, where the results of the pilot project were presented along with representations from other groups about their latest developments in web services related to Seismology.



RapidSeis workshop attendees

Overview

RapidSeis is hosted by the NERIES Data Portal and the user interface is deployed in two parts: an editor and executor tool. The user employs the existing Portal event and waveform tools to add datasets to their "My NERIES" data cart. The executor tool is used to manage data

processing where the user chooses which algorithm to apply to the data. The processing system queries the NERIES web services, caches the waveform data described in the cart and inserts the selected algorithm into the processing application. Results generated by the processing (e.g., images, output files, etc.) are posted to a web server and displayed via the executor tool.

New algorithms may be defined online by the user at any time using the editor tool. Algorithms are compiled and stored as binary plugins, and their descriptions written to Portal storage.

The architecture of this system is geographically distributed with Portal tools running in De Bilt, Paris and Liverpool; processing and web server loads are distributed over several machines in Liverpool. RapidSeis is a collaboration between the three existing technologies listed below, each of which required extension and further development.

SDX & plugins

Developed at the University of Liverpool, SDX (Seismic Data eXplorer) contains functionality to analyse seismic waveform data. The application's basic functionality can be extended with user-defined algorithms encoded using the C language as plugins. SDX is a cross-platform desktop application and was re-engineered for RapidSeis to enable a batch mode. It forms the core processing engine of RapidSeis and has two primary roles: it compiles source code plugins to binary code and provides an environment within which plugins are executed. Separate support modules were also developed to handle interaction with web services and to manage the processing workflow.

Rapid

Rapid is a framework that allows develop-

ment of customised graphical user interfaces within a web portal. These user interface web applications are deployed as standard portlets. Rapid was developed by the UK National e-Science Centre in Edinburgh with the aim of simplifying use of applications running on remote compute resources. RapidSeis imposed new demands on the framework (e.g., delivery of dynamic web pages), which necessitated further development of Rapid.

NERIES Data Portal

Jointly developed at ORFEUS and EMSC, the NERIES Data Portal brings together various individual standard tools (portlets). Through the portal the user interacts with map-based tools that enable the dynamic composition of a data product, and binds seismic event parameters with a set of seismic stations. This user interaction results in the aggregation of several sets of heterogeneous information obtained by the NERIES web service infrastructure (e.g., SeismoLink waveform web service, EMSC-QuakeML earthquakes catalogue service, etc.). The requested data are collected by back-end processes of the portal, preserved and offered to the user in the "My NERIES" personal data cart.

References to the core data are maintained through persistent URLs and metadata are generated as RDF and made available through a SPARQL endpoint. RapidSeis makes substantial use of this RDF archive. It queries the RDF archive (or "triple store") for information about which data products to download and process, and uses the same mechanism to read and write plugin source code and parameters. RapidSeis required extensions to the original Portal RDF model and functionality of the "My NERIES" data cart.

Executor Tool

Datasets are first marked as available for processing by checking an option in the "My NERIES" cart. The executor tool contains a list of named algorithms (plugins) that may be applied: the list contains plugins created by the user and any public (i.e., shared) plugins created by the community. When an entry is selected the executor fetches the plugin's meta-data (e.g., required input parameter descriptions, location of binary object, etc.) from the NERIES triple store. The user interface redesigns dynamically within the browser to accommodate the parameters and populates the page with editable text boxes containing default values, one for each required parameter. For instance, a Butterworth bandpass filter plugin requires parameters specifying the order and the high & low frequency cutoffs. The user assigns input values and initiates processing. The processing infrastructure queries the NERIES cart for datasets, retrieves the data, generates an SDX project file and executes SDX with the selected plugin.

Results are generated in the form of HTML pages and posted to a web server. The executor tool loads these pages and displays them to the user who may choose to download them. In the filter example

the processing results are displayed as an image of a set of filtered waveforms. The executor tool generates a list of links to all the results of processing jobs within the current session making comparison of results straightforward.

Editor Tool

Plugins are created, deleted or modified by the editor tool. The tool loads the list of available plugins from the NERIES triple store. When selected, a plugin description is loaded, the source code is retrieved from the triple store and opened for editing. Descriptions of required input parameters (i.e., name, data type and default value) are stored as comments within the plugin source. A check box specifies access to the plugin: the user can choose to share the plugin within the Portal community by making it publicly visible. The user makes changes and then tests if the plugin compiles correctly. The editor tool copies the plugin source code to the processing infrastructure where it is built against the SDX application. Any errors are reported back to the user in the top pane of the editor tool. If the user saves the changes, the processing infrastructure posts the plugin source code and associated metadata to the NERIES triple store as RDF. The metadata also in-

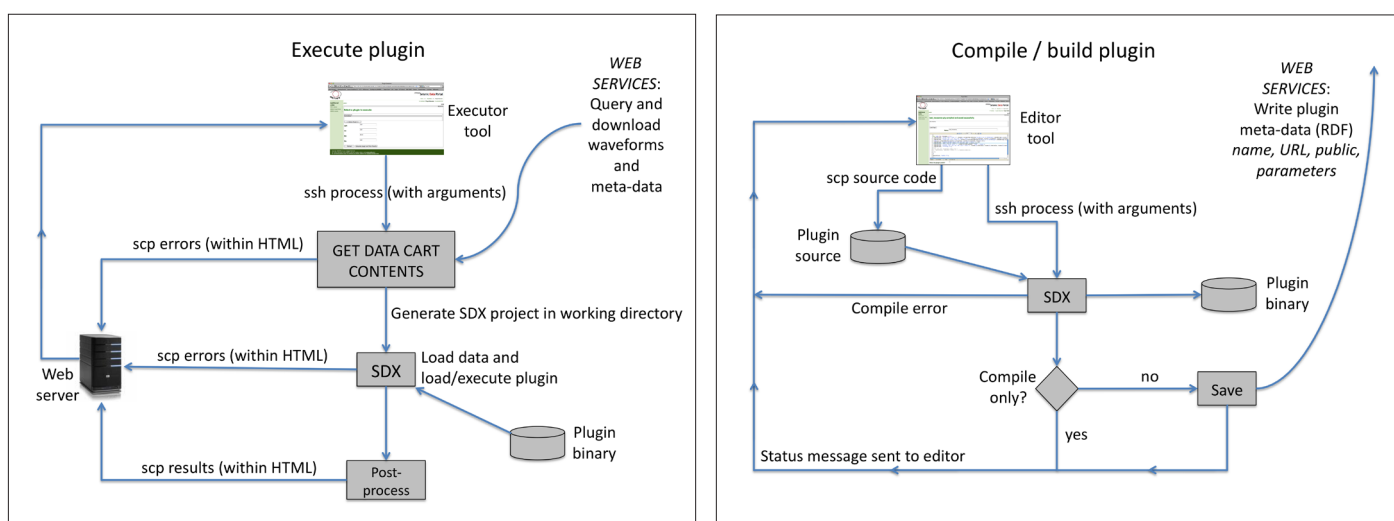
cludes the location of the plugin binary which is stored on the processing infrastructure where it will be needed when execution is requested.

Summary

This project used existing infrastructure for the analysis of seismic waveforms. We feel RapidSeis forms a framework that could be exploited in many different areas. Processing algorithms can be created online, stored and shared between users of a community web portal. There is no need to download data or install/learn the analysis package: a web-browser is all that is required. Further work would include development of the provenance metadata to improve traceability of data and processing activities, and refinements of both the plugin API and user interface tools.

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A YouTube video showing RapidSeis in use, is available under the "RapidSeis" tab of the NERIES Data Portal front page at <http://www.seismicportal.eu>.



NERIES (www.neries-eu.org) is an infrastructure project in which, among other components, the seismic data portal is being implemented. Both ORFEUS and the University of Liverpool are participants in this project. The UK National e-Science Centre of the University of Edinburgh (<http://research.nesc.ac.uk>) collaborates with NERIES since 2008 to pursue user friendly web applications. JISC (www.jisc.ac.uk) works with colleges and universities in the innovative use of digital technologies across education and research and provided financial support for the RapidSeis project.