Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation

Report

Global coordination in portal and web services developments

Activity:	*European Mediterranean Earthquake Portal and Web services*
Activity number:	*NA9*
Deliverable:	*Global coordination in portal and web services developments*
Deliverable number:	*D9.4*
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Seventh Framework Programme

EC project number: 262330

Contents

Summary

Future services providing raw and added-value, or integrated, data products require a well-defined data management structure, discovery tools, and a work-flow environment for added-value data products. Some of these elements are addressed in NERA NA2, SA1 and SA2. For compatibility, enabling integrating in a larger international context or a European infrastructure like EPOS, we rely heavily on developments in projects like EUDAT, VERCE, EPOS, EGI and COMMIT.

The data and metadata management and discovery is, beyond NERA NA2, SA1 and SA2, also addressed in a more general framework within these projects and the US (EarthCube). This is being closely followed and where possible integrated within our portal and service environment.

The tools for added-value data products are addressed for a large part in VERCE, an IT infrastructure project, as well. These elements are developed in close coordination to ensure that NERA and VERCE services become integrated.

This report is part of a set of reports, overviews and white papers that form the basis for a technical implementation plan for the seismological thematic services within the framework of EPOS. The NERA NA9 developments will consequently build a framework within the context of this technical implementation plan to ensure the services and portals developed within NERA are compatible and will at the end of NERA be integrated in the EPOS framework.

1. Introduction

This report summarizes the different elements necessary to develop the future services that provide raw and value-added, or integrated, data products. We are focused on access to seismic waveform data and earthquake information data provided by EMSC (SA1) and ORFEUS (SA2). The services anticipated, notably web services and portlets, depend on data management and discovery tools, and, for added-value data products, on workflow tool developments. Within NERA NA2, SA1 and SA2 some of these elements are being addressed. However, for future compatibility, we need to rely much on work done outside the consortium in, for example, other more IT focused projects. This poses a significant coordination challenge, which NERA and specifically NA9 has taken on.

Consequently, we summarize the state of the art of the service developments within NERA NA9 and a number of relevant developments outside the consortium, being integrated within the NERA NA9 work. The existing platform is presented as well as the data and meta data management developments in EPOS, NERA and VERCE, the global coordination, and the planning on how to integrate the different elements within the NERA NA9 developments.

2. Overview of on-going developments

NERA NA9 among other objectives is aiming at implementing a uniform data access layer for different seismological data and products. This goal depends on several aspects ranging from technical to more organizational and political ones, some of which go even beyond the scope of the project. Consequently, in order to implement a successful strategy, this cannot disregard other similar ongoing activities but rather it has to be well aware of the overall surrounding ecosystem. Especially related developments in infrastructures and services have

to be considered and acknowledged. In this respect NERA is well positioned as key participants and partners working on the main technical developments are deeply involved in other projects as well. This allows us to have a broad overview whilst still keeping clear in mind the main focus of the single activities.

This particular situation fosters also a technological contamination among different projects and research areas. In the following paragraphs we outline some of the ongoing infrastructure activities that we currently we liaise with and present some of their goals trying to give the general picture and how the different requirements fit in our integration roadmap.

2.1 European developments

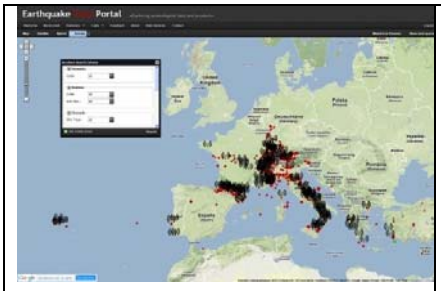
2.1.1 Earlier developments: the Earthquake Data Portal

The Earthquake Data Portal (EDP) provides a single point of access (www.seismicportel.eu) to diverse, distributed European earthquake datasets and products provided through a unique joint initiative by observatories and research institutes in and around Europe as depicted in Figure 1. Based on Internet-standard Java portlet and web services technologies, it enables the scientists/users to integrate and combine access to different data services.

The Data Portal aggregates portlet-based Data Explorers providing search and access functionalities to datasets from several NERIES (www.neries-eu.org) and now NERA activities, including event parametric information from the EMSC, broadband waveform data from the European Integrated Data Archive, accelerometric parameters and waveform data from participating EuroMed accelerometric networks, and historical data from the Archive of Historical Earthquake Data.

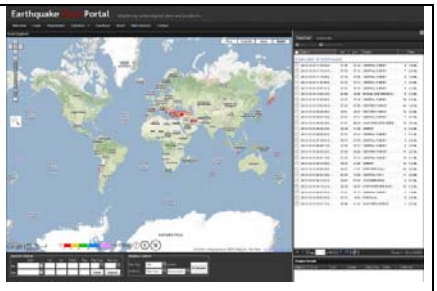
Data requests and the resulting datasets are managed in user Data Carts. These Data Carts are an important abstraction within the portal and for future developments. They maintain the URIs to references to the downloadable result datasets, and also provide a loosely coupled mechanism for inter-portlet communication and coordination. Additionally, by exposing the data cart services, they support a mechanism through which access to remote processing systems can be integrated into the portal.

The portal is built following the principles of Services-Oriented Architectures (SOA). The data explorer and data cart portlets provide interactive User Interface (UI) components that in turn invoke supporting data services. These data web services support both the portal and portlet applications, but are also available as public services. As such, external applications can be — and have been — written to invoke the data services directly. These external client applications are examples of the next generation of research applications that will directly access data stores and invoke distributed remote processing centers.

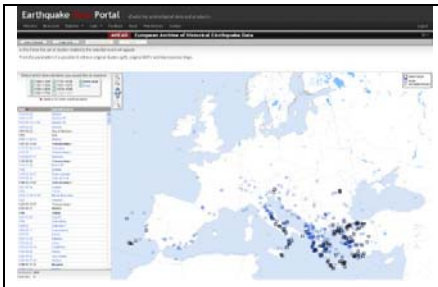


Accelerometric Waveform Explorer, data provided by NERIES NA5

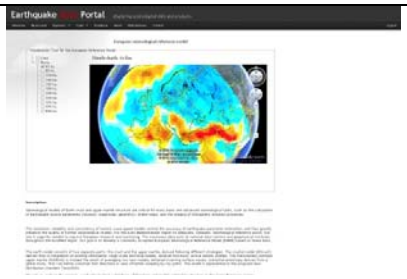
Broadband Waveform Explorer, data provided by NERIES SA2



Event Parametric Data Explorer, data provided by NERIES SA1



Historical Data Explorer, data provided by NERIES NA4



Reference Model Explorer, data provided by NERIES JRA1

Figure 1: *The Earthquake Data Portal (EDP) applications (www.seismicportal.eu)*

2.1.2 EPOS framework

EPOS is a long-term integration plan that aims to create a single sustainable, persistent and distributed solid Earth science infrastructure that includes geophysical monitoring networks, local observatories, experimental and analogue laboratories, integrated satellite data and geological information.

EPOS-PP (European Plate Observation System - Preparatory Phase) is an EC-funded project targeted at preparing the large-scale ESFRI roadmap infrastructure project EPOS. EPOS can be considered as a distributed Research Infrastructure (RI) composed of the individual RIs declared by each partner and associate partner. Each of the individual RI is constituted of components owned and maintained by different communities. One of the key challenges in this respect is to organize and manage such an heterogeneous and diverse knowledge quite often encoded in a broad variety of types and formats.

2.1.2.1 Research Infrastructures Database for EPOS (RIDE)

In order to have a clear picture describing the availability of resources and facilities, and to build up a solid base upon which founding the further developments, the EPOS WG7 designed a survey that was submitted to all the participants and to the responsible of the RIs. The final outcome of this survey was collected and coherently organised in what at the

present time constitutes an important asset for the preparatory phase: Research Infrastructures Database for EPOS (RIDE). The aim of the RIDE is to allow the EPOS RI to be organized, enabling the broad community of users and stakeholders with interactive access and data mining capabilities. The idea is to preserve and maintain this valuable knowledge base with the support of the other working groups and scientific partners. EPOS has also started to collect information concerning technical details, legal and financial status of all the national research infrastructures participating to the EPOS integration plan.

The main goals of RIDE can be summarized in:

- RIDE presents the contents of the EPOS integration plan to all stakeholders (data providers, users from scientific communities, governmental and funding agencies, as well as other stakeholders in public and industry)
- In the near future, RIDE will represent an appropriate tool to provide information to the discovery layer of the EPOS RI architecture, shaping the new metadata structure envisioned by WG7
- RIDE as a tool of the EPOS Core Services: once the EPOS core services will go into operation, RIDE will represent a descriptive database to disseminate and facilitate the use of data infrastructures, data products, etc.
- Integration of technical and financial/legal questionnaires: RIDE is a powerful tool to integrate collected information in an electronic database and to further collect new information. This integration is needed in order to harmonize the work of different WPs in the EPOS Preparatory Phase.
- For communities (i.e., working groups) with an advanced infrastructure integration, RIDE will facilitate the dissemination of existing data infrastructures. It will also promote discussions within the communities on their present data infrastructures. As a result RIDE will also be a powerful outreach tool for mature RIs.

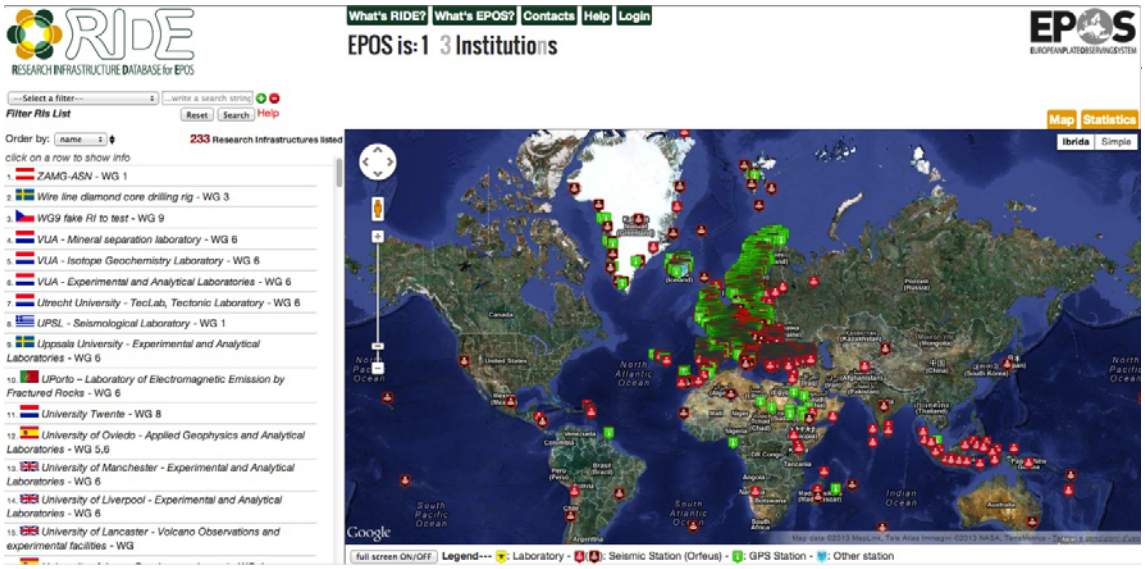


***Figure 2**: Overview of the RIDE portal (www.epos-eu.org/ride)*

2.1.2.2 Data model

An important effort in EPOS is currently addressing the design and implementation of its Data Model: one of the key components of the RI. This task has been identified as a crucial

achievement necessary for the accomplishment of the successive phases. EPOS is working in great synergy with IT experts and key domain experts in order to set up a metadata structure able to fulfill the major requirements coming from the different communities and summarized in a set of selected use cases.

A key requirement of any metadata stack is interoperability with other metadata standards to allow homogeneous access over heterogeneous data, software and services. The proposed stack is capable of interoperating with at least DC (Dublin Core), MARC, MODS, e-GMS, US International Dataset Standard, INSPIRE, CSMD all of which are more-or-less relevant to research (scientific) datasets and associated metadata. This is:

- discovery metadata: using extended qualified DC (Dublin Core) which is generated from:
- contextual metadata: using CERIF (Common European Research Information Format) which describes projects, persons, organizations, publications, products (including datasets and software), patents, funding, events and has declared semantics over a formal syntax allowing temporal role-based relationships between instances of entities and also handles geolocation. CERIF (with INSPIRE for geolocation data) then points to;
- detailed metadata: this is usually domain specific and associated with a particular dataset, software or service;

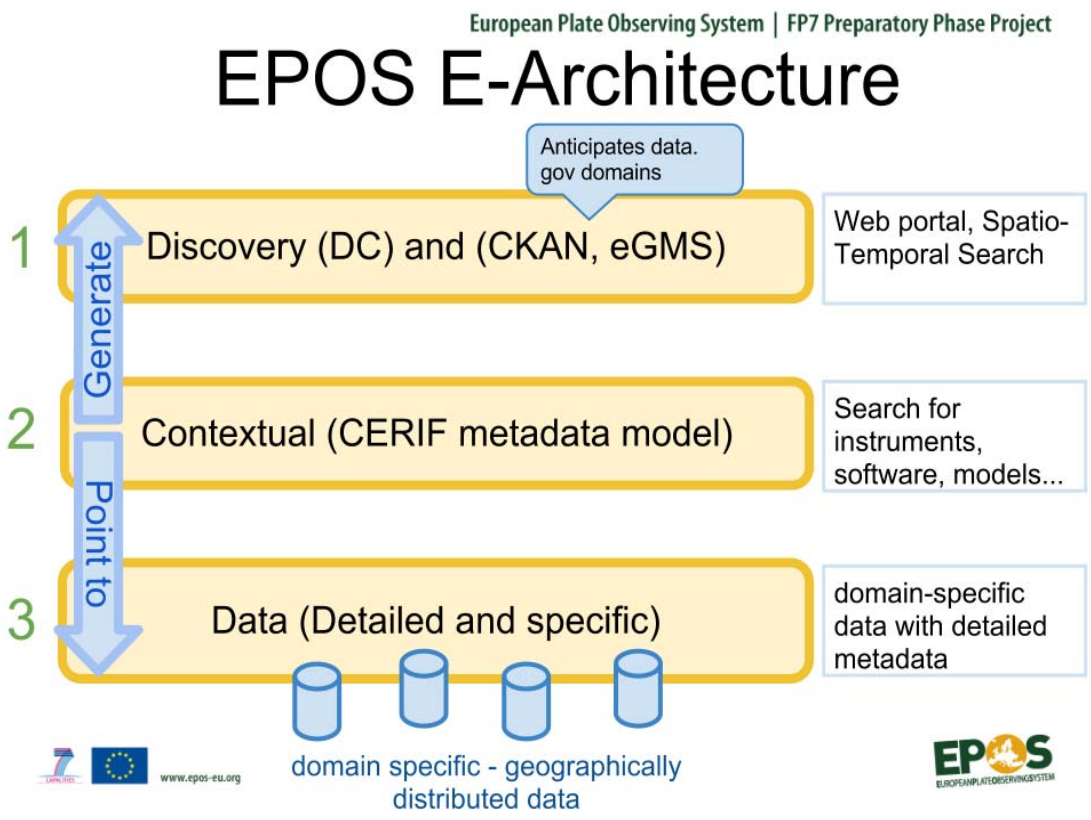


***Figure 3**: EPOS proposed metadata stack*

This activity is supported and coordinated with EPOS Working Group 1 (WG1) that is working on collecting and assessing the currently available domain specific metadata and services. In fact the seismological community represented in EPOS by ORFEUS understood the importance and need for renovation and restructuring of its data management and data provisioning services. It is well aware of the opportunity provided by such a large integration plan, therefore it is actively working in order to participate and steer the implementation of the new generation of services and tools. Currently scientists and relevant representatives of different seismological disciplines are working in synergy with IT experts at the classification and organization of their domain knowledge and best practices. This important preparatory task will be translated in a second stage into concrete implementation requirements and guidelines.

Similar activities are also ongoing within the other communities represented in EPOS by focused working groups like volcanology, geology and GPS.

2.1.3 Waveform data: Observational Seismology developments

The European Integrated Data Archive (EIDA) is a distributed data center initiative within ORFEUS targeted (a) to securely archive seismic waveform data gathered by European research infrastructures, and (b) to provide transparent access to the archives for the geosciences research communities. EIDA archives seismic waveform data from broad-band sensors, short period sensors, accelerometers and the corresponding metadata. EIDA, developed within NERA NA2 (NERA D2.1), aims at homogeneous data quality and uniform data access.

Currently EIDA can count on a network of several nodes, comprising the major seismological data centers distributed across Europe, which are interconnected via the Arclink protocol and share synchronized metadata information. The current architecture is operational and provides access for a substantial number of users throughout Europe and beyond. As such, technological improvements are under investigation and new developments have been initiated in a joint effort among the partners. These are mainly oriented at tackling common issues especially concerning scalability, but also at including new functionalities to better support higher level services. As an example we can mention the campaign for the definition and usage of persistent identifiers within the seismological community but also the definition of shared metadata catalog and services that are carried out in close collaboration with projects like EUDAT.

Another initiative going in this direction has been initiated by the FDSN and regards the definition (which has been completed) and the deployment (ongoing) of a set of standardized data services. In joint collaboration with IRIS and within the COOPEUS framework, EIDA is bringing together the major players in seismic data provisioning trying to create an uniform access layer to continuous waveform data, event data and station metadata (the latter encoded in a community proposed standard, namely: station-xml). This common access layer will enable clients interoperability and eventually also better retrieval strategies and tools (e.g: brokering). Another important activity is looking at the extension of the current set of data and metadata including strong motion data. This is carried out within the NA3 work package, for more details refer to deliverable NERA D3.2.

2.1.4 Waveform data and modeling: Coupling data and computational resources

The VERCE project targets the implementation of a single framework allowing the management and the execution of seismological applications on distributed and heterogeneous computing resources. These developments are conducted also in cooperation with the EUDAT, EGI and PRACE initiatives, in order to maintain a high level of integration and compatibility across data archives and institutional computational infrastructures.

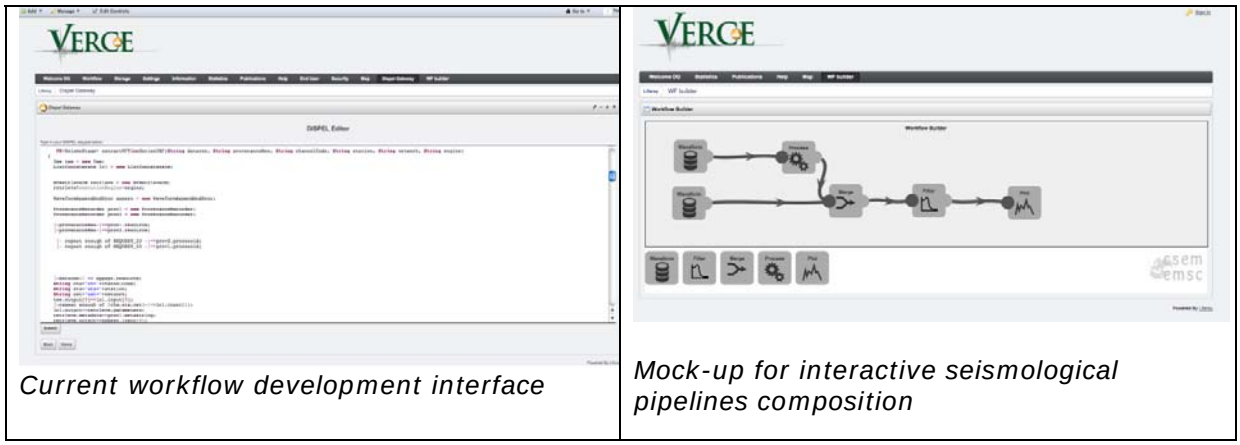
VERCE focuses on the implementation of a set of well-defined scientific use cases. The project has identified the computational models that fit the requirements of the different analytical components of each use case, classifying them as HPC or Data Intensive. Below there's a short description of the two main use cases which are currently under development.

Forward Modeling and Inversion: Aims at allowing the comparison of observed seismograms for earthquakes on a continental scale, with synthetic seismograms for various earth models. This use case requires the execution of seismic and wave propagation simulators (Specfem3D and Seissol) within institutional and local HPC resources. The VERCE project will provide the required abstractions and technologies for the of management of HPC job submission, data shipment and results visualization.

Seismic Noise Cross Correlation: This use case requires the execution of preprocessing pipelines and the cross correlation of a large number of seismic traces. The high volume of data involved in the computation and the need of frequent I/O operations, characterize this use case as Data Intensive. VERCE will provide the framework that will allow the integration of users' analysis code and community libraries of algorithms within the execution of each of the processing steps of the cross correlation.

VERCE will adopt a workflow management system for the implementation of the afore mentioned applications. The system will deal with distributing the computation across the available resources, hiding from the users the complexity of dealing with data transfer operation, authentication and resources allocation. The management of the data obtained as the results of the computation will take care of managing the policies for temporary and permanent storage. It will make use of provenance data produced by the computation to offer validation, visualization and comparison functionalities, fostering reproducibility and data-reuse.

Users will be enabled to configure, execute and monitor the workflows via a set of dedicated interfaces provided by the VERCE Scientific Gateway. The Gateway will represent therefore, the presentation tier to a unified framework, which gives access to several standard components. It fosters their communication with the computational infrastructures, encouraging or enforcing the governance rules that its community wishes to establish.



Current workflow development interface

Mock-up for interactive seismological pipelines composition

Figure 4: *The VERCE Scientific Gateway Prototype*

2.1.5 NERA OGC Data Integration Interfaces

As mentioned in section 2.1, the Earthquake Data Portal (EDP) consists of a collection of web services and tools running in different places. It offers dedicated applications, providing each of them discovery and access functionalities for a specific kind of datasets. For the NERA project we are trying to merge the user interfaces where it seems to be more convenient for the end user. This new data explorer will allow the discovery and the access to heterogeneous datasets via the interaction with the a map based user interface, which is generated by the invocation of Web Services Standards (OGC WMS, WFS). This approach aims to improve usability and interoperability between external applications and data services.

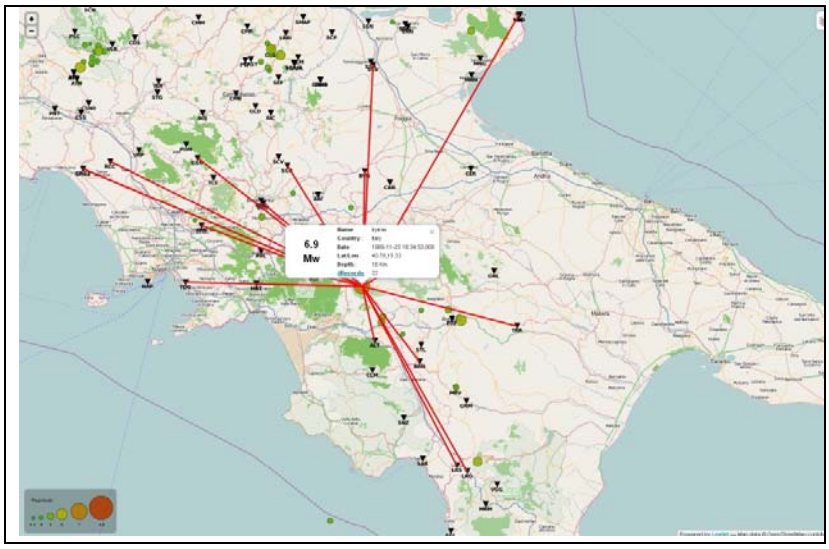


Figure 5 *: Example of an integrated User interface mixing different map and information. Here an earthquake in southern Italy is linked with the different stations recording the event.*

2.1.5.1 Current status of the developments:

Using MapProxy we can serve static base map to different Web service (OGC WMS and OsGeo TMS) as well as dynamic map generation from user request (generate from python with postgresql).

We have also implemented a map layer with moment tensors from the EMMA database and a test user interface showing the capabilities of mixing information from foreign provider using the OGC WMF standard and OSGeo TMS.

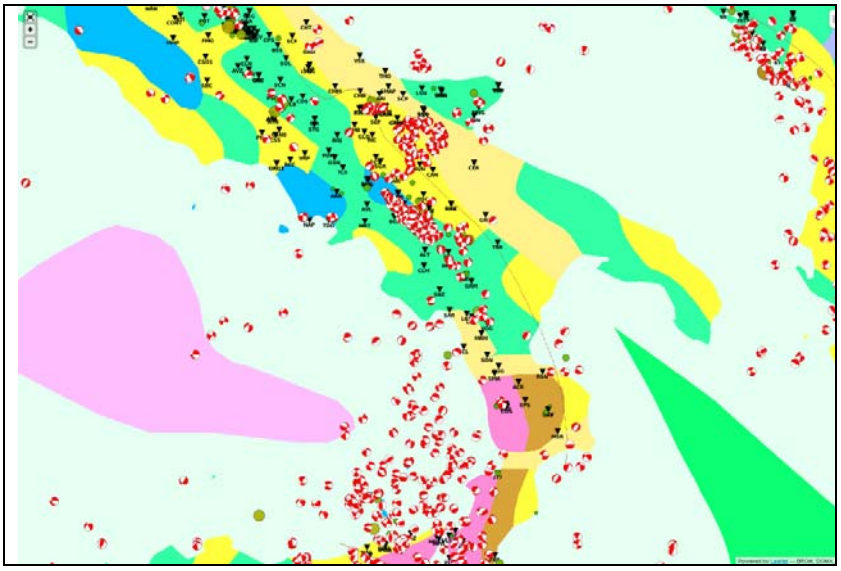


Figure 6 *Different layers on the same map : geological base map from OneGeology/BRGM in WMS format. Moment tensor TMS and events TMS served by EMSC as well as World Fault Zone WMS provided by the Canadian Natural Environment.*

We plan to integrate also some of the VERCE technologies, in order to provide processing functionalities which can be managed by the users via an advanced data cart or workbench, that will extend the functionalities already available within the current data carts available in the Earthquake Data Portal.

2.2 US developments and cooperation

The seismological services we provide should preferably be compatible with similar services elsewhere in the world to facilitate global seismological research. This is ensured through the FDSN where, currently, mainly the US and Europe are proposing the standards. Consequently, an intensive interaction has been and is currently channeled through the COOPEUS project.

2.2.1 Web services and the broker concept

The NERIES project developed the first European web services for waveform data in Europe. IRIS-DMC and UNAVCO are following with two concepts within The EarthCube initiative (http://earthcube.ning.com/page/concept-awards); the web services and the broker concepts. Within the FDSN four standard web services with regard to data type 0 and 1 have been agreed on. IRIS-DMC has an extensive web service library and plans to extend this.

The four standard web services will be implemented in Europe at individual ORFEUS-EIDA nodes (NERA NA2) within the COOPEUS project. The IRIS-DMC promoted concept for distributed archives is the Federated Archives, in which a broker leads the user to the associated archives. A merging of both concepts is currently being reviewed within the ORFEUS EIDA management.

2.2.2 USGS developments and coordination with EMSC and ISC

The NEIC (National Earthquake Information Centre) of the US Geological Survey mainly focuses on rapid earthquake information targeting as prime audiences general public and media. As such, the use of web services is mostly limited to specific features (and for more or less internal reasons) such as the determination of the local time or the determination of the name of the region where an earthquake is located. Similarly, the International Seismological Centre (ISC) is also developing some specific web services as tools to improve their service. Neither ISC nor NEIC has been involved in the development of a portal comparable to the one developed in the NERA project.

3. Integration and on-going work

NERA with strong involvement of ORFEUS plays a key role tackling the huge challenge of integrating and coordinating on-going different IT developments aimed at providing convenient users access to more high quality data and products. This work is being channeled through WG1 of the EPOS preparatory Phase project.

3.1 EPOS WG1 specifically ORFEUS, EMSC, EFEHR and engineering integration planning

NERA's long term vision with regard to integrating the services of SA1, SA2 and SA3 is discussed within NA9 in close collaboration with EPOS WG1, lead by ORFEUS and the other projects mentioned in this report. A schematic plan is depicted in Figure 6. While much of the technology is discussed in section 2 of this report, the discussions on what kind of services the community needs is being stimulated within EPOS WG1. We expect this community to work out a more comprehensives science and technology plan during 2013. The basic ideas, three categories and their respective on-going work, are summarized here:

Category I. Seismological data; waveform data and related products

Key developments are SeisComP3 (important monitoring network acquisition and analysis package) being widely distributed and promoting (real-time) waveform data exchange. To ensure access to an increased amount of data the European Integrated waveform Data Archive (EIDA) has been created under the umbrella of ORFEUS (NERA NA2). Data access is improved by the implementation of ArcLink and standardized Web services. The data holdings have been extended beyond broadband data to include data from other sensors, temporary deployments (NERA NA2), acceleration and strong motion data (NERA NA3), historical seismograms, ocean and sea floor networks, synthetic seismograms, and infrasound data. Date service improvements, QC, products, access services, etc. are addressed within both NERA NA9 and SA2 and SA1, the VERCE project (www.verce.eu) with regard to both data intensive and computational intensive services. The COOPEUS (www.coopeus.eu) EC project provides some funding for US-EU cooperation, among others in implementing standardized web services in seismology.

Category II: Seismological products; event catalogues and related products

Key developments are real-time products (earthquake alerts, shakemaps, …) European earthquake bulletins and catalogues, both historical (SHEEC - www.emidius.eu/SHEEC), historical data (AHEAD - www.emidius.eu/AHEAD), Outreach, i.e. earthquake information, background and educational information/material has also improved significantly both on a national level and the EMSC (SA1). The REAKT (www.reaktproject.eu) project is coordinating rapid alert initiatives, NERA NA8 includes school seismology, and catalogue work is done within SHARE (www.share-eu.org) on a European scale and integrated within NERA SA3. The EMSC (www.emsc-csem.org) plays a leading coordinating role in Europe.

Category III: Services in seismic hazard and risk

Key developments are integrated / unified European hazard and risk products as developed within the SHARE and SYNER-G (www.vce.at/SYNER-G) projects and carried further within NERA and GEM (www.globalquakemodel.org). Additional products & services are emerging from the multi-hazard / multi-risk focused project MATRIX (http://matrix.gpi.kit.edu), and the developments in time-dependent hazard and risk assessment in NERIES and REAKT. The European Facility for Earthquake Hazard and Risk EFEHR (www.efehr.org) (NERA SA3) is set up as central access and dissemination platform for these hazard and risk products. While its long-term governance structure is yet to be established (within EPOS), it is envisioned that SA3 (EFEHR) also provides the coordination platform for further seismic hazard and risk related initiatives in Europe. GEM plays a key role in the international coordination.

The services we consider are in particularly concerned with Category I and II. However, the integration with Category III has to be considered as well and is anticipated around 2014 – 2015 (see Figure 6).

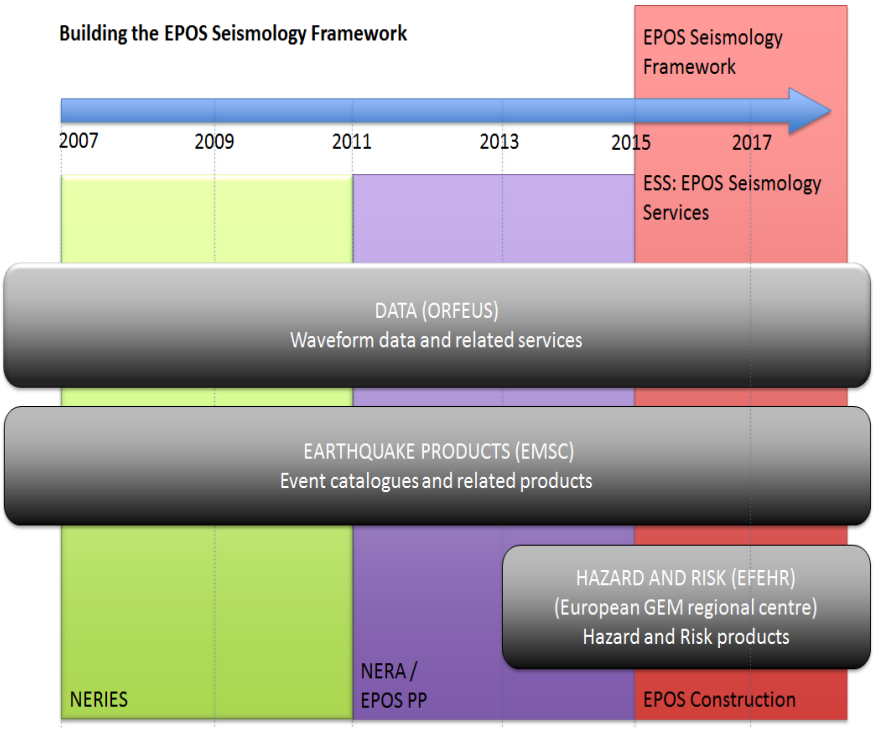


***Figure 7**. The draft time line for building the seismological, risk and hazard blocks into one integrated services.*

3.2 VERCE project and specific NERA NA 9 interactions

The collaboration with VERCE, mentioned before, is focused on added-value data services and integration with computational resources, which is VERCE's main task. The technology provided by VERCE will potentially impact on the redesign of the data services currently provided by the data archives, providing also the unified framework in which new and more complex data processing functionalities can be implemented.

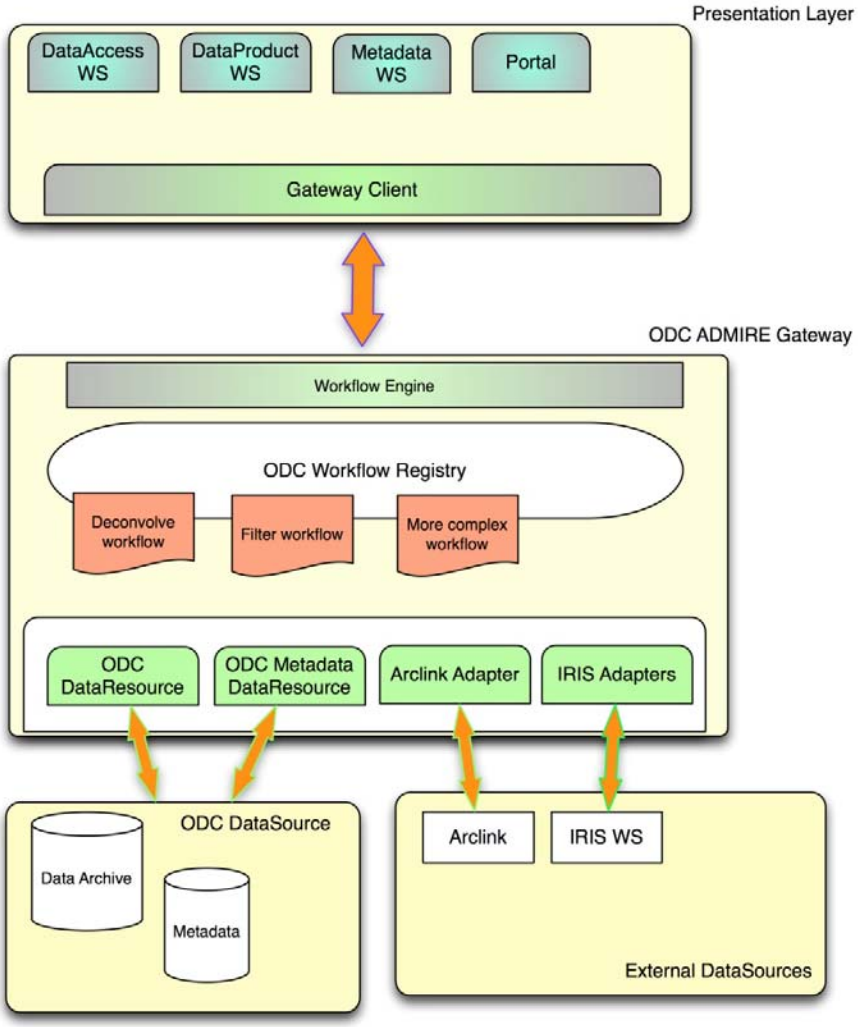


***Figure 8**. Schematic overview of the gateway implementation as being implemented at the ODC enabling workflows. The gateway enables one to implement both simple and complex data processing functionalities.*

3.2.1 Workflow implementations

Figure 8 Illustrates how the workflow technology can be used within the data archive's infrastructure, establishing therefore, a common layer for the data access and the generation of new data products. The workflow engine developed within VERCE, will be able to execute a number of workflows performing customizable transformations on the requested data. Such system could offer, for example, services like filtering, instrument correction, visualizations, etc. Obviously, with respect to the VERCE project objectives, the

scale of the computation and the nature of the data products are expected to be scaled to the limited computational resources available at the data archives sites. On the other hand, this is not excluding the possibility of a scale-up, as soon as these resources become available.

3.2.2 Gateways facilitating portal interaction

The VERCE developments related to the Scientific Gateway will also give the opportunity to evaluate a newer portal technology, keeping at the same time, a high level of compatibility with the standards adopted by the Earthquake Data Portal (EDP). This could facilitate the exchange of applications and tools between the two portals, besides the redesign and the reimplementation of some of the EDP applications, as already anticipated in section 2.

3.2.3 Integration of NERA and VERCE platforms

VERCE aims at investigating data preservation strategies besides the adoption of agreed metadata vocabularies for the relevant data products. The system will allow annotations and vocabularies extensions besides standard metadata, in order to give to the users better flexibility when describing the results of their experiments. The implementation of these functionalities could help to improve the metadata vocabularies and the formats currently adopted by the EDP. Additional information related to the provenance of the new products, together with a common identification system (in cooperation with the other international initiatives) will foster the interoperability between the NERA and VERCE platforms and beyond.

3.3 EMSC – USGS – ISC

EMSC-USGS-ISC have been organizing a yearly coordination meeting for the last 8 years. Although there is no web services effort on their side comparable to the NERA portal, we still coordinate on the development of web service such as the one for determining the Flinn-Engdahl regions. This coordination is integrated in our daily operations. The next meeting is planned early September at the ISC premises.

4 Discussion and conclusion

Figure 6 depicts where the infrastructure service coordination discussion are focused on. Within NERA the following WP are directly (NA9 – leading, NA2, SA1, SA2) and more indirectly (NA3, NA4, NA5 and JRA2) involved. However, outside NERA a number of projects are developing basic IT tools for data management, standardization to facilitate service integration, and tools for added-value data products. To ensure compatibility and sustainability of the services and portals developed NERA needs to follow those developments closely. We have solved this by working closely together with those initiatives where possible.

We are certainly aware of the challenge. This is well recognized in the US since the NSF restarted all similar Earthscience-IT initiatives within EarthCube. Consequently, we are closely following those developments. A large number of formal and informal meetings have been held starting with an IT coordination meeting February 8-10, 2012 in De Bilt.
This report is part of a set of reports and overviews being compiled to form the basis for a technical integration plan being prepared for seismological ‘thematic services’ as envisioned within the integrated EPOS infrastructure.

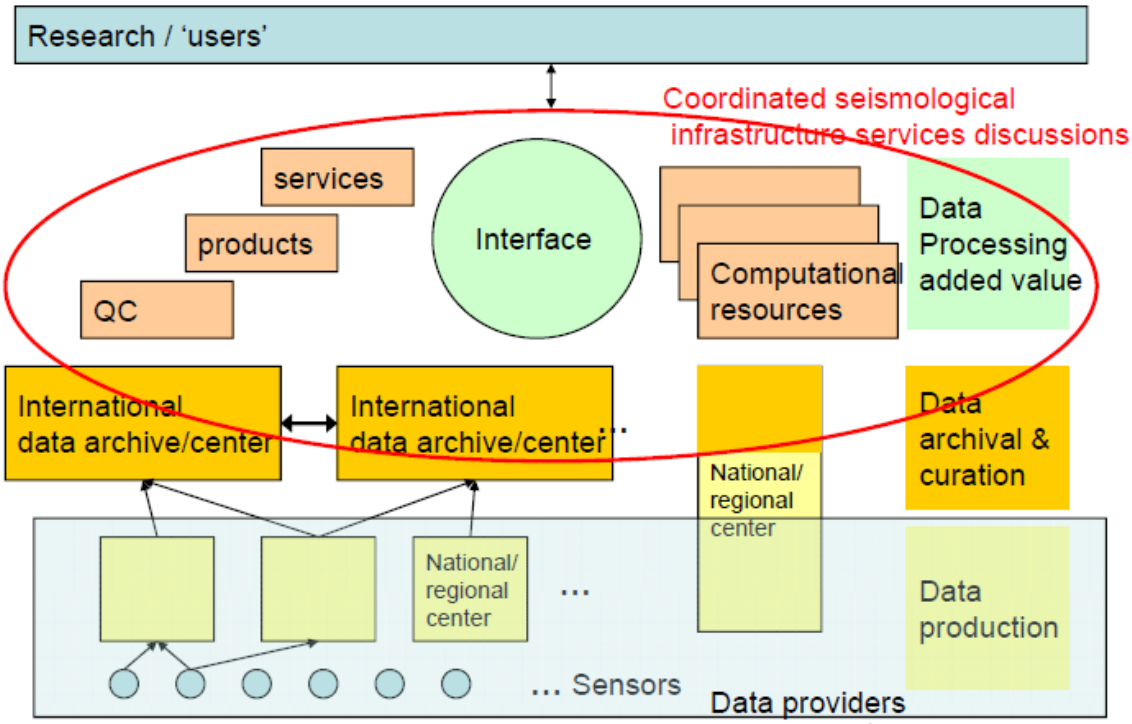


Figure 9. Schematic overview of the on-going developments related to portal and services. The encircled area indicates where the different elements need to become compatible. The integration framework for the long-term is EPOS. The work itself is mostly done within NERA (data oriented – data integration) and VERCE (computational oriented – value-added data products).

Glossary

CERIF – Common European Research Information Format
COOPEUS – Connecting research Infrastructures – EU-US cooperative project (www.coopeus.eu)
EarthCube – A community driven data and knowledge environment for the Geosciences (http://earthcube.ning.com)
EDP – Eurthquake Data Portal (www.seismicportal.eu) Developed within NERIES and being updated within NERA.
EFEHR – European Faclitiy for Earthquake Hazard and Risk (www.efehr.org)
EGI – European Grid Infrastructure (www.egi.eu)
EIDA – European Integrated waveform Data Archive (developed in NA2)
EMSC – European-Mediterranean Seismological Centre (NERA participant)
EPOS – European Plate Observing System (www.epos-eu.org)
EUDAT – European Data Infrastructure (www.eudat.eu)
FDSN – International Federation of Digital Seismograph Networks: www.fdsn.org
GEM – Global earthquake Model (www.globalquakemodel.org/)
GEO – (Ad hoc) Group on Earth Observations: earthobservations.org/
GEOSS – Global Earth Observation System of Systems www.epa.gov/geoss/index.html
GRID - Computational Grid (www.gridforum.org) and/or Database grid (www.globus.org).
GUI – Graphical User Interface.
INSPIRE – Infrastructure for Spatial Information in the EC (http://inspire.jrc.ec.europa.eu/)
IRIS – Incorporated Research Institutes for Seismology (US foundation)
IRIS-DMC – IRIS Data Management Center (Seattle, Washington, USA)
ISC – International Seismological Centre, Thatcham, Berkshire, UK: www.isc.ac.uk
NERIES - Network of Research Infrastructures for European Seismology EC-project RII3-CT-2006-026130 www.neries-eu.org
ODC – Orfeus Data Center
OGC – Open Spatial Consortium – geospatial and location standards (www.opengeospatial.org)
ORFEUS – Observatories and Research Facilities for EUropean Seismology; non-profit international foundation (NERA participant) www.orfeus-eu.org/
QC – Quality Control
QuakeML – Global XML standard for earthquake parameter data being developed within the NERIES project in collaboration with US and Japan partners (www.quakeml.org).
RIDE – Research Infrastructure database for EPOS (www.epos-eu.org/ride)
SCEC – Southern California Earthquake Center (www.scec.org).
SHARE – Seismic Hazard Harmonistation in Europe (www.share-eu.org)
SOA – Service Oriented Architecture
UI – User Interface
UNAVCO – non-profit university-governed cnsortium facilitating geodesy research and education (www.unavco.edu)
USGS – United States Geological Service, responsible for NEIC
VCE – VCE Holding GmbH (participant NERA)
VERCE – Vitual earthquake and seismology Research Community in Europe e-science environment
XML – Extended Markup Language (relevant for web pages)