

ORFEUS Strategic Plan

Evolution of broad-band seismology in Europe
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Foreword

This document describes the status and evolution of the strategic planning of ORFEUS. This planning was initiated in summer 2001 and is expected to come to completion in summer 2002, with the preparation of an application for support to the EU and ESF. The on-going activities and future actions towards the definition of the ORFEUS Strategic Plan are described here.

Evolution of broad-band seismology in Europe

European seismology is undergoing a major revolution as the monitoring systems are moving from traditional analogue technology to digital recording. This transition started in the early 1980s through local or regional research networks (Geoscope, MedNet, Geofon) and today most of the national networks have either completed or are working toward fully digital systems. Within 5 years hundreds (300-400) permanent broadband seismic observatories will be deployed in Europe, operated by over 30 different networks.

ORFEUS (Observatories and Research Facilities for European Seismology) was founded in 1987 to serve as European regional centre with the specific goal of serving the research community by ensuring the availability, exchange and quality control of digital waveforms. It also serves as European representative in the global Federation of Digital Seismic Networks. The KNMI in De Bilt, The Netherlands, hosts ORFEUS and contributes to its operation with personal support. ORFEUS funding is secured by the payment of national quotas by, presently, 12 European countries. Within Europe ORFEUS co-operates with EMSC (European-Mediterranean Seismological Center), responsible for earthquake parameter data exchange, under the auspices of the European Seismological Commission (ESC).

ORFEUS served well the research goals for which it was designed, but the situation is rapidly evolving and we need to plan how seismological data collection and exchange will operate in the future in Europe. We lack today a large-scale centralized facility with the capability to access, archive and distribute all real-time seismological waveform data gathered throughout the European-Mediterranean region. Although individual national investments in observations throughout Europe are on par with the US, the larger amount of data remains scattered over tens of observatories and data-centres and is practically inaccessible for large-scale scientific investigations. The ORFEUS infrastructures are an order of magnitude smaller than similar existing centres in the US. The consequences in terms of delays in research programs are felt widely. Without a European scale initiative the situation will deteriorate.

The present limitations in the ORFEUS structure (lack of long-term funding, voluntary national contributions, bottom-up structure, scientists driven organisation) prevent from establishing a long-term strategy. Until now, European support to ORFEUS consisted of the long-standing support of the ESC and the ESF, and of one short-term infrastructure EC-project (MEREDIAN). We need to establish a long-term sustainable strategy for a lasting large-scale seismological facility in Europe, capable to accommodate the rapid shifts in technology and political conditions together with the continued commitment required for the long-term observation of the Earth.

Present concerns and future needs

A number of concerns need to be addressed in establishing a strategic plan for ORFEUS.

Long-term waveform archiving and distribution

At the beginning of the 20th century large European earthquakes were recorded by over hundred stations worldwide and half of these analogue seismograms can still be retrieved and used today. We need to plan to make European records for present-day earthquakes accessible 100 years from now. With the entry in the digital era we need to define a strategy that will allow storage and retrieval of data for decades and centuries in the future. Innovative concepts in distributed databases (i.e. NetDC) are under test at ORFEUS, but maintaining an efficient and safe European archive distributed through tens of national and network centers, will prove difficult, probably impossible with the present infrastructure due to varying national budget limitations, shifts in political support and short lifetime of many network projects. However, the rapidly improving communication infrastructure and the decreasing price of large storage media now permits the design of a centralized archive, where all European event and even continuous data could be freely available through electronic transfer. A centralized database would also offer the option of a safe back-up to national and regional data-centres.

Earthquake surveillance and real-time requirements

The future European alarm system will be based more and more on real-time access to regional and global broad-band waveforms, for the computation of digital magnitudes, seismic moments and more precise locations. Most national agencies today require real-time access to waveforms collected outside of their territory in order to obtain reliable location and digital magnitudes for national surveillance. Centralized, coordinated, real-time waveform collection and distribution at a regional scale is needed to avoid a disruptive superposition of bi-lateral exchanges. Such an exchange requires the willingness of national networks to make their data available for real-time open access and centralized data accessibility. Virtual Seismic Networks (VSN) in the US (IGPP/UCSD, IRIS/DMC, USNSN/NEIC) and at CTBTO/IDMC provide instant access to several hundreds to more than a thousand of stations; only a few tens of stations are available in Europe through ORFEUS.

Temporary and semi-permanent broad-band deployments

Today broadband waveforms from permanent stations provide the bulk of ORFEUS data. But other types of waveform data also require a centralized facility. Europe has yet to find a solution for the mass of data collected by national and regional (Europrobe) temporary experiments, which only seldom are openly available and are too often lost soon after the experiment. This is not the case in the US, where PASSCAL waveform data (temporary stations and experiments) is the dominant component in the IRIS DMC. In Europe, only few countries (D, F, UK, CH) have established national pools of portable instruments and even here mechanisms to make these data available to the international community are not pursued.

Ocean-bottom networks

A number of European institutes are acquiring Ocean-Bottom Seismometry capability, and are participating in deployments of OBS or mixed ocean-land based experiments. Technologies and logistics are still expensive, requiring ship-time and a powerful research institute behind. Existing projects focus on institute or national pools. However, as prices come down and more European institutes are able to handle deployment and data retrieval, it is now feasible to plan a European network or pool for long-term deployments. A European pool could be used to monitor and investigate high-interest areas of the Euro-Mediterranean region which are by definition in

international waters. A European pool would also enlarge the participation to OBS science to many smaller research institutes and countries.

Quality control

Due to the fragmentation of resources and projects, no efficient quality control on European stations/waveforms quality is possible today beyond that performed by individual operators or through user feedback.

Europe versus the US

European countries devote large resources to seismology, but boundaries and different national priorities severely limit the establishment of an efficient regional co-operation. With comparable area, seismic hazard and risk exposure, the US set up a backbone of centralized federal facilities to supplement the regional and local networks. A new wave of monitoring projects in the US includes: the new 5-year plan for IRIS (covering the GSN, PASSCAL and the DMC), the new Advanced National Seismic System (over 1000 SM stations for urban hazard), EarthScope (including 1000 BB stations for the California Plate Boundary Observatory and the portable high-resolution USArray) and the Enhanced Atomic Energy Detection System Network (AEDS, for baseline global coverage of nuclear testing). All these projects are characterized by the large-scale regional dimension and the open, centralized access to all collected data. Seismological infrastructures in the US and Europe are managed differently, with national agencies playing a very strong role in Europe in network operations and data distribution. Today, in Europe we need to boost competitiveness and provide both research and surveillance activities with the best possible access to data.

ORFEUS and EMSC

The European tasks regarding earthquake data is presently divided between the EMSC taking care of the parameter data distribution and archiving, and ORFEUS taking care of the (broad-band) waveform data distribution and archiving. Both operate under the auspices of the European Seismological Commission. Each has its own organizational and financial structure. The rapid warning of medium-to-large size earthquakes in the European-Mediterranean area will require a close co-operation between the two organizations.

European Research Area

A shift in research policy is taking place with the start of the EU 6th Framework Program. As part of the new European Research Area paradigm, existing frameworks are enlarged to foster networking, exchange of data, mobility of scientific personnel, access to large-scale facilities and training of young researchers. ORFEUS is well positioned to give a contribution to the definition of the European Research Area and to qualify for some of the associated funding frameworks. These possibilities could build the backbone of a future ORFEUS expansion and consolidation.

Strategic Plan

The definition of a Strategic Plan for ORFEUS started with a Planning meeting in De Bilt on July 4-5, 2001, under the auspices of the ESF. Meetings within Europe and with US partners (IRIS) in the following months resulted in a better definition of the goals and expected milestones of the strategic plan. Feasibility and cost/benefit analyses were performed for different technical solutions. Contacts

with EU and ESF were intensified, as well as with colleagues and agencies across Europe. The three main strategic areas of the future ORFEUS are outlined below.

I. ORFEUS Data Centre

ODC will extend its goals and operations to

- archive in an expanded centralized facility all event and continuous waveform data (primarily BB data) from all European stations and networks, provide a fast distribution channel for all waveforms and build a safe duplicate archive for national data-centres
- build a Virtual Seismic Network to provide real-time exchange of waveforms and real-time processing of earthquake parameters
- archive waveform data from mobile and semi-permanent experiments
- implement a fully integrated Data Management Centre with IRIS-DMC, with duplicated databases and dual access for the global seismological community

II. European instrument pools

ORFEUS will coordinate and encourage or taking an active role in the development of European instrument pools:

- a European BB instrumentation pool for semi-permanent deployments in areas devoid of sufficient station coverage
- a European Ocean Bottom Seismographic Network, located in a permanent or semi-permanent mode along the European continental margin and in the Mediterranean, to complement the land-based networks

III. Outreach and Research

ORFEUS will

- coordinate an enhanced outreach programme, including a program for seismological instrumentation in European schools
- organize courses and workshops to advance the knowledge on using broad-band instrumentation and waveforms
- participate in EU training and mobility networks and in EU networks of excellence targeted to broad-band signal processing and seismology
- take an active role in developing tools for systematic wavefield modelling, shakemaps, early warnings, etc. (i.e. create a Working Group if deemed necessary)

Implementation schedule

A number of key actions are conducted towards the completion of the Strategic Plan.

- A Strategic Planning Document is under preparation, including many of the sections above, a Science Plan and a mid-term expansion scheme for ORFEUS. The Strategic Plan will be submitted to ESF for evaluation, to the EU and to national agencies by summer 2002.

- A Science Plan is under preparation by the ORFEUS ExeCom, covering the main scientific contributions achieved by broad-band seismology in the last years, and a summary of key scientific objectives we want to achieve in the mid-term future.
- An evaluation of the relevance and performance of digital seismology is being conducted, in the framework of the priorities of the EU 6th Framework Program and of the new European Research Area, to identify future perspectives and calibrate future needs, to verify the status of our science within the Earth sciences and more generally within the natural sciences. This evaluation will be part of the Strategic Planning Document.
- ORFEUS will participate to all the relevant EU 6th Framework Program calls, to establish the individual goals listed above. By June an Expression of Interest to participate in the “Networks of Excellence” will be submitted.
- Ongoing consultation with EMSC is expected to bring to a better integration of goals and activities.