Recent improvements in the Broadband seismic networks in Portugal

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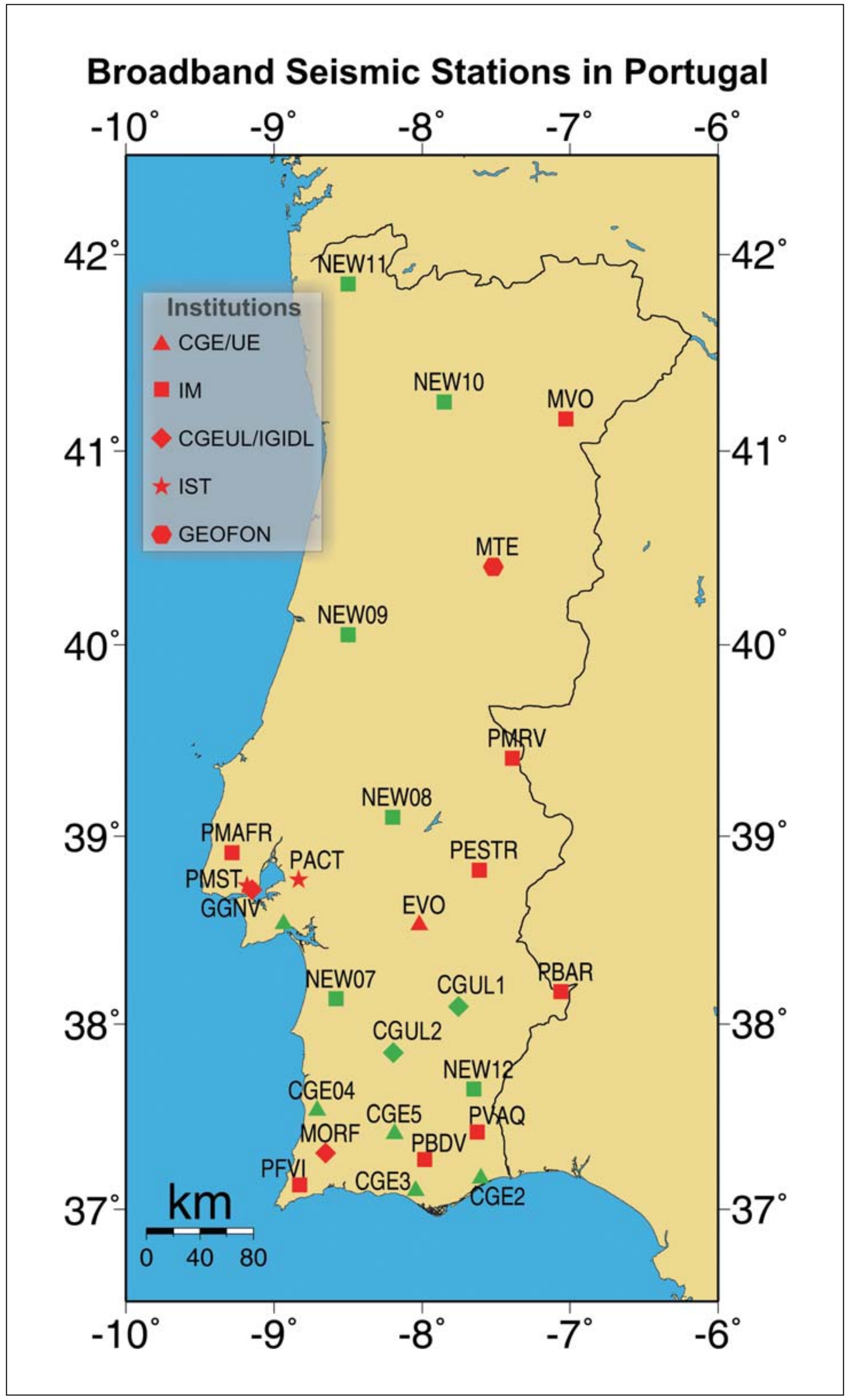
Introduction

Portugal, in spite of the significant earthquake region, (e.g.: Borges et al., 2001) has been operating a limited number of broadband digital seismic instruments. The older BB seismic station in a systematic and continuous operation on the country is MTE, belonging to GEOFON and locally supported by IM, which is working since 1997. To efficiently carry out the task of develop the Broadband Portuguese seismic network, there is a collaboration between some national institutions, such as Institute of Meteorology (IM), Geophysics Center of Évora University (CGE/UE), Geophysics Center of University of Lisbon (CGUL/IGIDL) and Instituto Superior Técnico (IST), with governmental support from the National Science and Technology Foundation (Rede Nacional de Geofísica, RNG). From this collaboration we expect shortly to assist the emergence of a high quality infrastructure, significant to real-time monitoring the earthquake activity for use by governmental authorities, and of paramount importance to scientific research. The installation of this network is to be carried out in narrow connection with international institutions as GEOFON, EMSC, ROA, ORFEUS, with who we saw to establish collaborations. Data from some stations are already being exported to international data centers, such as DMC and ORFEUS, and will be used for an upcoming prototype of an Early Warning Tsunami System to be developed for Cadiz Gulf coastal area and southwestern coasts of Portugal mainland, within the framework of the NEAREST project.

While the broadband network is developed they elapse investigation projects that request short period data. Of these projects we highlight the Seismic Tomography of the Continental Lithosphere of Algarve (Portugal) that involve the installation of a Portable seismic network consisting of 30 short-period stations, including a subnet of 7 telemetry stations, in operation since January 2006.

Figure 1: The distribution of the 14 real-time broadband seismic stations in Portugal Continental as of February 2007 (red symbols) and proposed sites (green symbols) to place the now acquired instruments (13 stations).



Broad Band Seismic Network design

The earthquake distribution within Portugal shows that the seismic activity has higher levels in some areas in southern part of Portugal mainland (e.g.: e.g. Carrilho et al., 2004), regions that we plan to use denser seismic station network coverage in order to record lower magnitude earthquakes. This will provide an earthquake database that can be used in more other applications that the seismic observatory and surveillance, such as earthquake source and structure studies which are crucial in understanding of Portugal seismotectonics, and attenuation among others.

The map of Figure 1 shows the actual situation of the seismic real-time broadband coverage in Portugal Continental. 12 VBB (120 sec) and 2 BB stations are now installed, with 2 of them running since mid-2006 and 5 from beginning of 2007; of the VBB, 3 (EVO, MTE and PMAFR) are equipped with STS2 sensors and Quanterra or Earth Data digitizers; the remaining are provided with GURALP sensors (3ESP, 3T and 40T) and CMG DM24 digitizers. 8 of the VBB (PESTR, PMAFR, PFVI, PVAQ, PBDV, PBAR, PMRV [to start on March] and MVO) stations are additionally equipped with strong-motion accelerometers. The BB stations (GGNV, MORF) are equipped with a 30s sensor. Real-time waveforms transfer from stations to the servers is managed by SeisComp/SeedLink, running at each station on Linux. Data communication from the permanent stations to the network server of each institution is performed by several ways. The IM stations (or PM network), the majority, use VSAT; the CGE stations use Internet based communication and the others stations (PMST and PACT) use telemetric transmission of data.

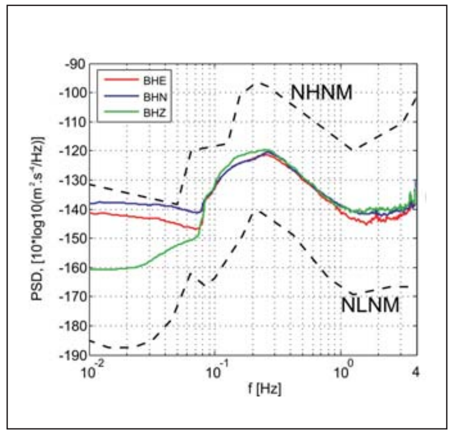
The security of data is guaranteed through an infrastructure with a high level of redundancy. The archiving of raw waveform data (mini-SEED) is made on a mass storage system (each participant institution it is responsible by the safeguard of the data from its stations). These data are real-time exported, by Internet, from the servers of responsible own institutions to the mirrors of the institutions that collaborate. The CGE network server sends the data of EVO to PM and Western Mediterranean (WM) servers and receives CART, MAHO, MALA, MELI and SFS from WM network (see Davila et al., this issue) and PESTR data from PM network. Data from MORF station is transferred directly to PM and then exported, together with PESTR, to CGUL/IGIDL

Quality control

One of the goals of the responsible broadband networks is to ensure that stations produce the maximum possible amount of high-quality, problem-free, data. Our Quality Control practices can be roughly categorized as examining the data for problems in the following tests: sensitivity and orientation; sensitivity and polarity; review of mass position channels.

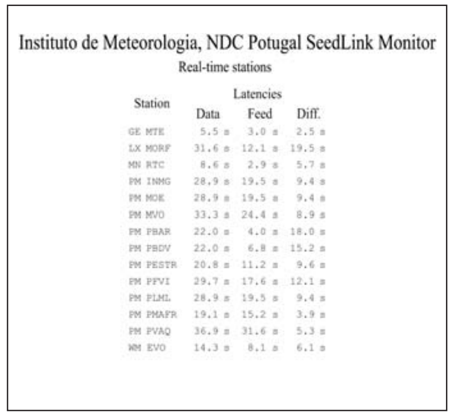
The stations are sited in very different environments ranging from near shore at the Atlantic Sea coast up to distances of about 200 km from the coast, both within cities and industry or traffic roads. New stations are being sited far from those artificial noise sources. To characterize the seismic noise level recorded by each seismometer we are to develop automated power spectral density analyses that will allow continuously check the seismic noise level (Figure 2).

Figure 2: Power spectral density of seismic noise estimated for the station EVO from data acquired during October, 20 and November 21, 2006 for the three components, vertical (Z), north–south (N) and east–west (E). The lower and upper dash curves are the low (NLNM) and high (NHNM) noise models of Peterson (1993).



Another import issue is to monitor the status of real-time data, and for that purpose a latency updated information is produced (using Seiscomp tools) to help the station operators to check for problems (Figure 3).

Figure 3: An example of a real-time data status screen at IM data center.


Instituto de Meteorologia, NDC Potugal SeedLink Monitor

Real-time stations

Station	Latencies Data	Feed	Diff.
GE MTE	5.5 s	3.0 s	2.5 s
LX MORF	31.6 s	12.1 s	19.5 s
MN RTC	8.6 s	2.9 s	5.7 s
PM INMG	28.9 s	19.5 s	9.4 s
PM MOE	28.9 s	19.5 s	9.4 s
PM MVO	33.3 s	24.4 s	8.9 s
PM PBAR	22.0 s	4.0 s	18.0 s
PM PBDV	22.0 s	6.8 s	15.2 s
PM PESTR	20.8 s	11.2 s	9.6 s
PM PFVI	29.7 s	17.6 s	12.1 s
PM PLML	28.9 s	19.5 s	9.4 s
PM PMAFR	19.1 s	15.2 s	3.9 s
PM PVAQ	36.9 s	31.6 s	5.3 s
WM EVO	14.3 s	8.1 s	6.1 s

Conclusions

The currently purpose is to finish the installation of new stations acquired (green symbols on Figure 1). However, we intended to obtain means to enlarge the broadband covering to a wide mesh similar as the proposal for other European countries (about 30km). Other initiative that we intend carry out is to develop one infrastructure of a portable broadband seismic network for experiments involving onshore recording of controlled source and natural seismic events. We expect to obtain these facilities through the "Rede Nacional de Geofísica" project.

The always present objective is the enlargement of International collaborations with other organizations toward common objectives as: disaster reduction, in particular earthquake disaster reduction; education and training; promotion of joint researches.

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