Romanian Seismic Network

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Introduction

The National Institute of Research and Development for Earth Physics (NIEP) was founded in February, 1977, to coordinate the research activities related to earthquakes in Romania. NIEP is co-ordinated by the Romanian Ministry for Education and Research.

As main task, NIEP carries out the seismic survey of Romania and operates the national seismic network. It has a wide background in earth sciences research, with focus on seismic source and seismotectonics, seismic hazard assessment, site effects and microzonation, lithosphere structure and dynamics, earthquake prediction, assessment and mitigation of seismic risk. Given its demanding operational mission, key objective of NIEP is the development of an advanced seismic data collection and management system, including robust real-time data acquisition techniques, reliable communications links, rapid processing and exchange of earthquake information, compilation of bulletins and earthquake catalogues.

Romanian Seismic Network

NIEP operates a real-time seismic network consisting of 18 short-period stations, 14 of them located in the Eastern and Southern Carpathians and telemetered to Bucharest, 4 stations sited in the Western part of Romania and telemetered to a regional recording center. The data recorded by the short-period stations are telemetered through analog radio line to the data centers at Bucharest and Timi_oara, where they are digitized at 50 samples per second, with 16 bit resolution.

Both data centers (Bucharest and Timi_oara) use an automated and networked system for the on-line digital acquisition and processing of the seismic data, providing real-time earthquake information (Oncescu et al., 1996), discrimination between local and teleseismic events. The results are rapidly distributed, via Internet, to several seismological services around the world to be used in the association / confirmation procedures and for contributing to unified bulletins.

NIEP also operates a free-field strong motion network consisting of 36 Altus - K2 seismic stations for recording the strong and moderate Vrancea earthquakes. The K2-network, centered around the Vrancea seismic zone and covering an area with a diameter of up to 500 km, has been installed in Romania recently (1995-1997), in the framework of the Romanian-German cooperation, within the

project **"Strong Earthquakes: A Challenge for Geosciences and Civil Engineering" of the University of Karlsruhe, Germany** (Bonjer et al., 2000).

The K2 stations are equipped with both accelerometer sensors (EpiSensor) and velocity sensors (broadband - CMG3ESP, KS2000 or short period - MP, SH-1, S13).

Since July 2002, a new seismic monitoring station, the Bucovina Seismic Array (BURAR), has been established in the northern part of Romania, in a joint effort of the **Air Force Technical Applications Center, USA**, and the NIEP. The new seismic monitoring system is fully operational by continuous recording and transmitting data in real-time to the National Data Centers of USA, in Florida and of Romania, in Bucharest.

BURAR consists of 10 seismic stations located in boreholes and distributed on a 5 km x km area. 9 stations are equipped with short-period (SP) vertical sensors (GS-21 res) and one station is equipped with broad-band (BB) three component sensor (KS 54000).

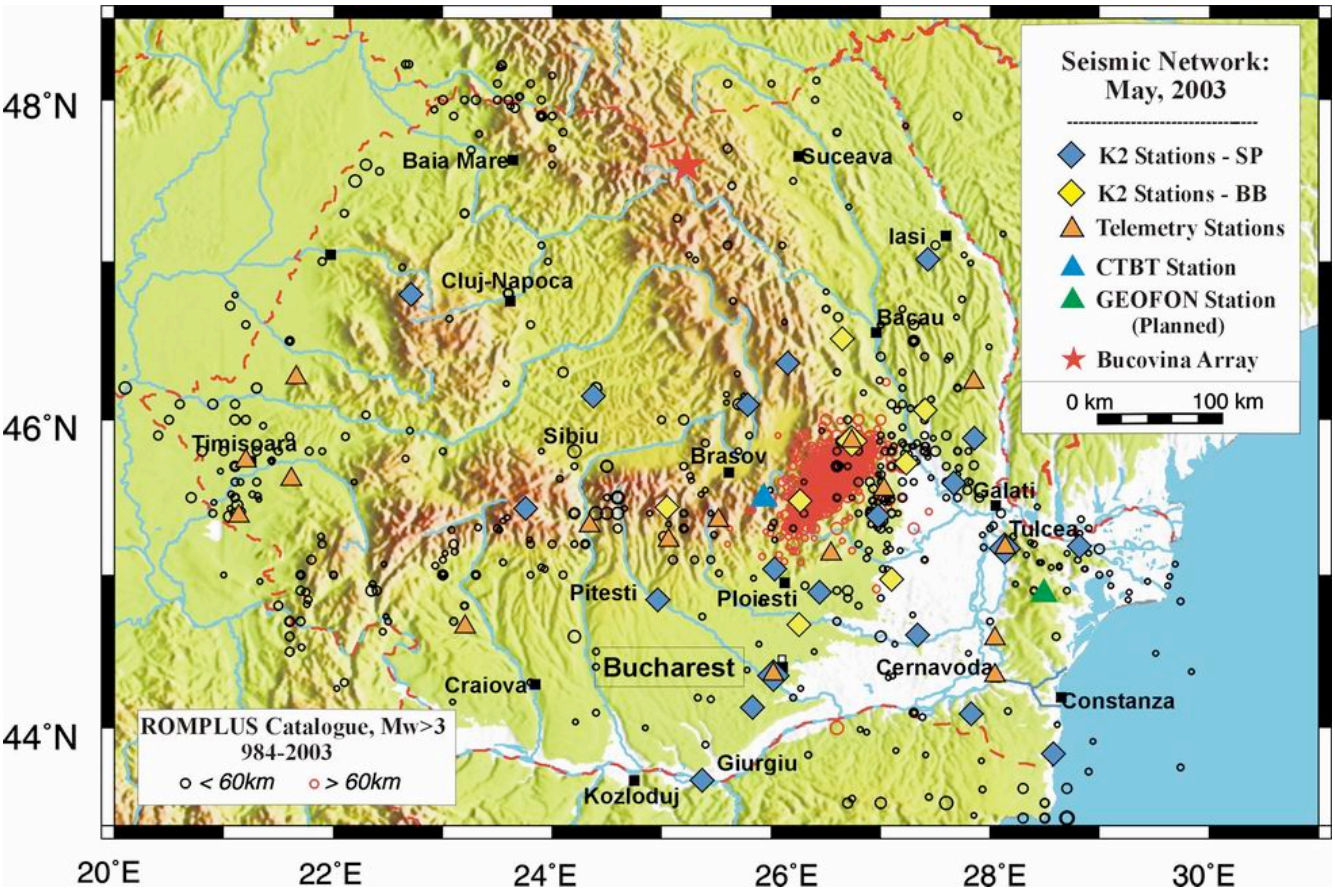

Figure 1. Romanian Seismic Network

Broadband Seismic Network

Recently NIEP has developed its real-time digital seismic network. This network consist of 7 broad band stations, one seismic array (see Table 1 and Figure 2).

SeedLink and Antelope program packages are used for real-time (RT) data acquisition and exchange. Broadband data from station BUC1, IAS, DRGR, VRI,CRAR and TIRR are transferred to the SeedLink server at the RO_NDC in RT through VSAT or Internet . Between MLR station and the Antelope system at RO_NDC we use qt2orb connection and between BURAR array and RO_NDC we use CD12orb connection (Fig.2).

Near-future strategy includes development of the real-time digital seismic network. In the next six month NIEP will install two additional broad band stations the K2 station in middle of Romanian territory and the DM24 station in west part of Romania and in 2005 year NIEP will install new stations. Data will be transmitted continuously to the Bucharest data centre, using satellite communications or land radio link (Figure 3).

For real time data acquisition and analysis from BB seismic stations , 12 short period stations and BURAR seismic array we use Antelope software.

Table 1. Broad band stations existing in Romania

BB Station	Station Code	Digitizer	**Lat**	**Long**	**Elev**	Sensor	Sampling rate	Data transfer
Muntele Rosu, CTBT station	MLR	Quanterra 4120	45.4909	25.9450	1360	BB STS2	40 sps	Real time- radio link
Targusor, GEOFON station	TIRR	EarthData	44.4581	28.4128	77	VBB STS2	40 sps	Real time- VSAT link
Vrancioaia	VRI	Altus-K2	45.8665	26.7276	472	CMG3ESP	40 sps	Real time – VSAT/radio link
Bucharest	BUC1	Altus-K2	44.3479	26.0281	77	KS2000	40 sps	Real time – TCP/IP
Bucovina Array	BURAR	SCIENCE HORIZONS	47.6148	25.2168	1150	KS54000	40 sps	Real time - VSAT link
Dragan,	DRGR	Altus-K2	46.7916	22.7111	921	KS54000	40 sps	Real time- VSAT link
Iasi,	IAS	Altus-K2	47.1933	27.5617	160	CMG40T	40 sps	Internet
Craiova,	CRAR	Altus-K2	44.3250	23.799906	125	CMG40T	40 sps	Internet

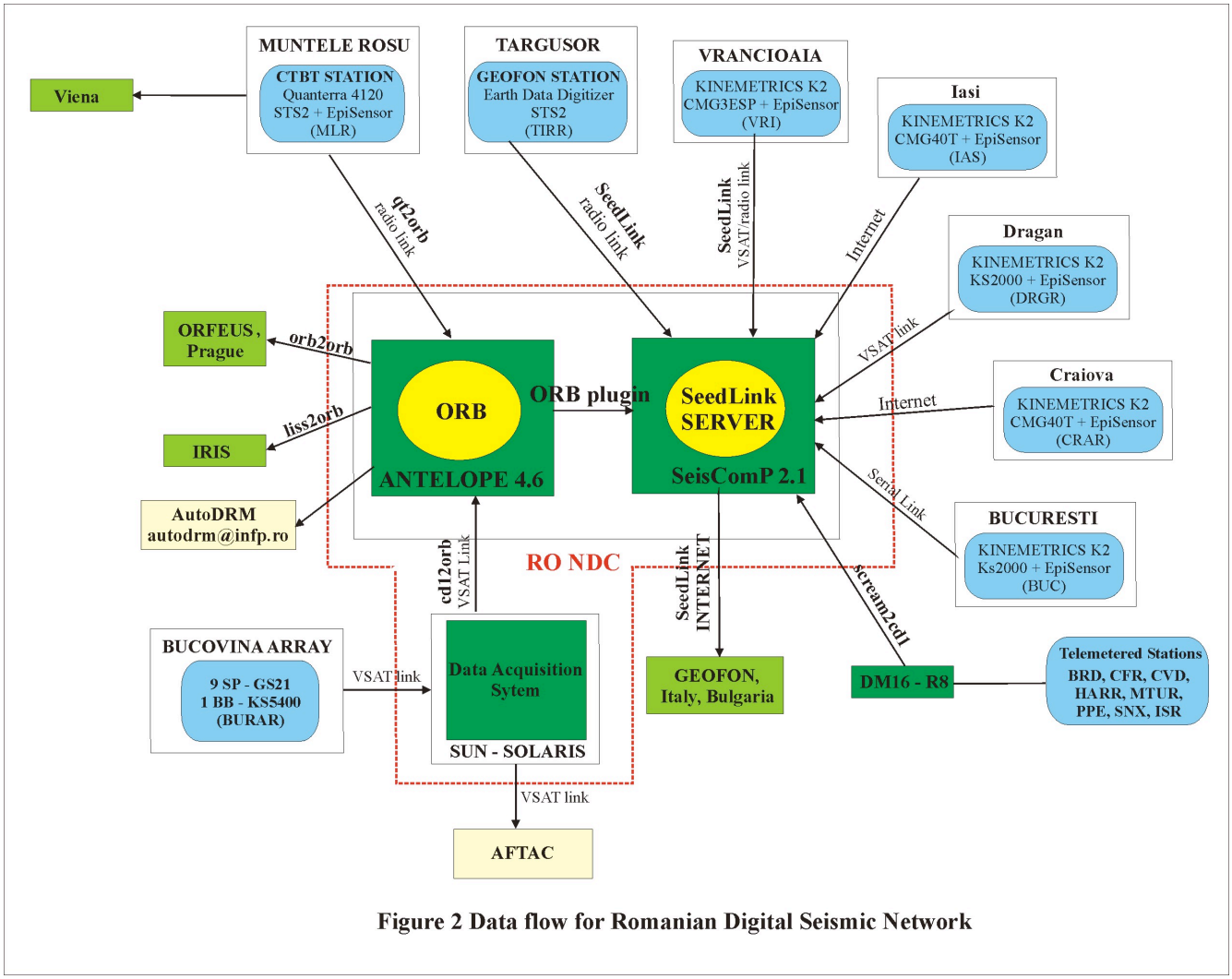

Figure 2 Data flow for Romanian Digital Seismic Network

Table 2. Data storage and availability

Data Recorded by	Data Type	Data Storage	Data Availability
Telemetered network	Continuous	CDROM	Available through AutoDRM (format GSE 2.0 and 2.1)
K2 network	Event data – local events	CDROM	NO
MLR CTBT station	Continuous	DVD	yes
GEOFON station	Continuous	DVD	yes
Bucovina Array	Continuous	Magnetic tape	Yes
K2 BB_station	Continuous	DVD	Yes
Short period stations	Continuous	DVD	Yes

Figure 2 Real-time seismic network of Romania.

Real-Time Data Exchange

NIEP supports two ways of real time data exchange following the MEREDIAN project requirements: orb2orb (Antelope) and SeedLink (GFZ-Potsdam), but at present, only SeedLink is fully operational with GEOFON Potsdam, MEDNET and Bulgarian Data Center.

NIEP contributes to ORFEUS Data Center with data in near real time from VRI, MLR, DRGR, BUC1 and TIRR(via GEOFON) using orb2orb connection.

AutoDRM

The AutoDRM was configured and implemented on Antelope software. At present, 30 days of data can be retrieved via AutoDRM (autodrm@infp.ro).