The Interreg IV Italia-Austria "SeismoSAT" Project: connecting Seismic Data Centers via satellite

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ABSTRACT. Since 2002 OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale) in Udine (Italy), the Zentralanstalt für Meteorologie und Geodynamik (ZAMG) in Vienna (Austria), and the Agencija Republike Slovenije za okolje (ARSO) in Ljubljana (Slovenija) are using the Antelope software suite as the main tool for collecting, analyzing, archiving and exchanging seismic data in real time, initially in the framework of the EU Interreg IIIA project "Trans-national seismological networks in the South-Eastern Alps" (2004, Bragato et al., 2004 and Bragato et al., 2010). The data exchange has proved to be effective and very useful in case of seismic events near the borders between Italy, Austria and Slovenia, where the poor single national seismic networks coverage precluded a correct localization, while the usage of common data from the integrated networks improves considerably the overall reliability of real time seismic monitoring of the area (Fig. 1). At the moment the data exchange between the seismic data centers relies on internet: this however is not an ideal condition for civil protection purposes, since internet reliability is poor. For this reason in 2012 the Protezione Civile della Provincia Autonoma di Bolzano in Bolzano (Italy) joined OGS, ZAMG and ARSO in the Interreg IV Italia-Austria Project "SeismoSAT" (Progetto SeismoSAT, 2012) aimed in connecting the seismic data centers in real time via satellite. The general schema of the project, including first data bandwith estimates and a possible architecture are here illustrated.

The border region of Slovenia, Austria and NE Italy has experienced several destructive earthquakes in the past. Different seismic networks are operating in the area supporting monitoring, alerting and research. The example of recent strong earthquakes demonstrated that the integration of services provided by the neighbouring networks is essential for a rapid and efficient intervention.

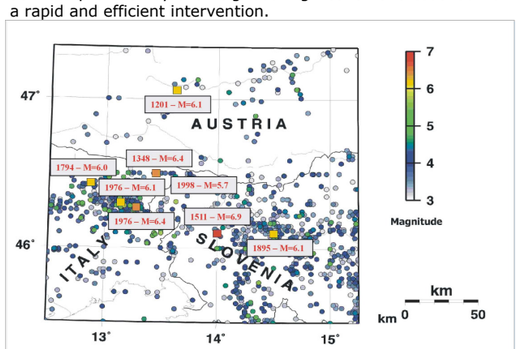

Fig. 1 Seismicity map of the border region between NE-Italy (Friuli Venezia Giulia), Austria and Slovenia. In the map the events with magnitude > 3 are shown. In the rectangle the date and magnitude of the major historical events are reported.

Fig. 4 Satellites at OGS are already in use to connect seismic stations to the data center in Udine; for the SeismoSAT Project technical capabilities and financial costs of the following satellite providers in the Interreg area will be investigated: EutelSat, Astra, Hellasat and possibly others.

Fig. 2 SeismoSAT map with seismic stations in red and data centers in blue

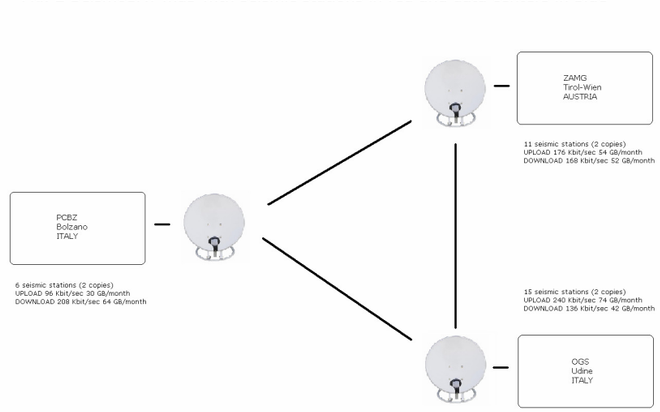

Fig. 3 SeismoSAT schematic diagram with data bandwidth requirements

The average bandwidth of station list indicated in Tab. 1 is 2.46 Kbit/second. This number is calculated on a normal seismic noise mode, where data compression is quite efficient, which is not true in case of seismic event. In order to accomplish enough bandwidth for transmitting seismic data also in harsh conditions like in case of a big earthquake, we fixed a bandwidth requirement of 8 Kbit/sec per each seismic station.
Total bandwidths required per network are then:
NI OGS 120 Kbit/sec
OE ZAMG 88 Kbit/sec
SI PCBZ 48 Kbit/sec
Each data center has to upload to the satellite network 2 copies of his network data, one for each of the other 2 data centers.
Total upload bandwidth required are therefore:
OGS 240 Kbit/sec
ZAMG 176 Kbit/sec
PCBZ 96 Kbit/sec
While download bandwidth required are:
OGS 136 Kbit/sec
ZAMG 168 Kbit/sec
PCBZ 208 Kbit/sec
Satellite contracts often includes 'fair policy' limiting total amount of data transmitted per month. Therefore expected monthly data bandwidth for SeismoSat are:
OGS 74 GB/month upload, 42 GB/month download
ZAMG 54 GB/month upload, 52 GB/month download
PCBZ 30 GB/month upload, 64 GB/month download

The Antelope software suite has the capability to exchange data in real time among data centers: for this purpose the standard "orb2orb" software module is used. It uses a proprietary protocol and a point-to-point client/server architecture to exchange data. The last release of the Antelope software suite contains a more sophisticated version of this data exchange module: it is named "orbxchange". "orbxchange" is a multithreaded version of "orb2orb" which supervises multiple "orb2orb" copies specified in a parameter file; it has the option of switching to alternate servers when no data is being copied from the primary. A distributed real time seismic database has been so established by connecting ZAMG, CRS/OGS, DST/UTS and ARSO Antelope servers with "orbxchange" modules (Horn et al., 2007). A test of the above described "orbxchange" features has been conducted artificially shutting down the Antelope servers and/or the data links between them: the results in the data coverage of the multiple copies of the distributed database showed an improvement in data availability that will be very useful for the institutional activities (like rapid earthquake location with magnitude estimation) of the institutions involved, but moreover its natural extension will be in more mission critical applications, like in public civil protection applications and rapid notification of inherent authorities like in the SeismoSAT Project (Fig. 3).

NI	ACOM	Acomizza	2,4
NI	AGOR	Agordo	2,1
NI	BALD	Monte Baldo	2,9
NI	CGRP	Cima Grappa	2,4
NI	CIMO	Cimolais	1,8
NI	CLUD	Cludinico	2,4
NI	DRE	Drenchia	3,0
NI	FUSE	Fusea	2,9
NI	MARN	Marana	3,5
NI	MPRI	Monte Prat	2,7
NI	PRED	Cave del Predil	3,3
NI	SABO	Mt. Sabotino	2,7
NI	VARN	Col Varnada	2,8
NI	VINO	Villanova	1,7
NI	ZOU2	Zouf Plan	2,4
OE	ABTA	Abfaltersbach	2,7
OE	ARSA	Arzberg	1,2
OE	DAVA	Damuels	1,5
OE	FETA	Feichten	2,4
OE	KBA	Koelnbreinsperre	1,5
OE	MOA	Molln	1,2
OE	MYKA	Terra Mystika	2,4
OE	OBKA	Obir,Austria	2,5
OE	RETA	Reutte	2,6
OE	SOKA	Soboth	2,5
OE	WTTA	Wattenberg	1,8
SI	ABSI	Aberstükl	2,8
SI	BOSI	Bozen/Zivilschutz Zentrale	4,0
SI	KOSI	Kohlern/Titschen	2,7
SI	MOSI	Großmontoni/Vinschgau	2,7
SI	RISI	Rein in Taufers/Ahrntal	2,6
SI	ROSI	Roßkopf/Sterzing	2,6

Tab. 1 Station list (Fig. 2) with bandwidth in Kbit/sec
NET codes: NI OGS, OE ZAMG, SI Prot. Civ. BZ

ACKNOWLEDGEMENTS
The authors wish to thank the Interreg Italia-Austria (2007) Authority for the financial support on the ERDF (2000) Fund and all the colleagues of OGS, ZAMG and Protezione Civile della Provincia Autonoma di Bolzano not mentioned here for their support to the SeismoSAT Project.

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