THE INTERREG IV ITALIA-AUSTRIA "SEISMOSAT" PROJECT
CONNECTING SEISMIC DATA CENTERS VIA SATELLITE

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ABSTRACT

Since 2002 OGS in Italy, ZAMG in Austria, and ARSO in Slovenia are exchanging seismic data in real time. At the moment the data exchange between the seismic data centres relies on internet: this however is not optimal for civil protection purposes, since internet reliability is poor.

For this reason in 2012 the Protezione Civile di Bolzano in Italy joined OGS, ZAMG and ARSO in the Interreg IV Italia-Austria “SeismoSAT” Project aimed in connecting the seismic data centres in real time via satellite. The general schema of the project, including data bandwidth estimates and the data links architecture will be illustrated.

KEYWORDS

satellite, data centre

INTRODUCTION

The border region of Slovenia, Austria and Northeast Italy is seismically very active (Fig. 1) and has experienced several destructive earthquakes in the past. OGS, ZAMG and ARSO seismic networks are operating in the area supporting research, monitoring and alerting to local and national authorities. 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. At the moment the data exchange between the seismic data centres relies on their internet connections: this however is not an ideal condition for civil protection purposes, since the reliability of standard internet connections is poor. Generally internet connections can provide high bandwidth at relatively small cost, but could suffer of disruption of service in case of strong natural events like big earthquakes. Same is true for mobile GPRS/UMTS data links, where data bandwidth is even less. Satellite links, apart from the problem of antenna dislocation by strong earthquake, if provided with reliable power supply can provide more robust data connections. The seismoSAT project will make use of satellite technology as back up for the primary internet data link between data centres. ARSO does not belong to the Interreg Italia-Austria region: for this reason ARSO joined the SeismoSAT project as an "associated partner", which, according to Interreg rules can not be funded. ARSO participation in the project is therefore at the beginning limited in benefiting only indirectly from improvement in the robustness of the data exchange between the other data centres, while eventually fully taking part in the project if other sources of funding will be available. The project is in the preliminary implementing phase: the general architecture of the project with data bandwidth estimates and a first satellite provider candidate will here be illustrated. The SeismoSAT project is funded by the Interreg IV Italia-Austria (Interreg IV Itlia-Austria, 2007) program based on the European Regional Development Fund (European Regional Development Fund, 2000).

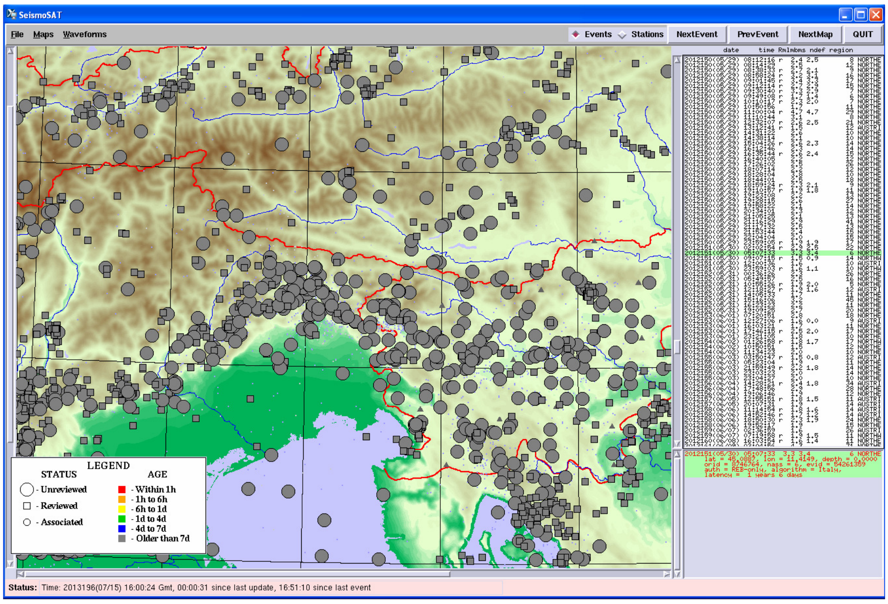

Figure 1 - Seismicity map in the years 2011-2012 of the border region between Northeast Italy, Austria and Slovenia. In the map the events with magnitude ML > 1.5 are shown. The plot is produced with the Antelope software.

NETWORKS AND BANDWIDTHS

A map of the seismic stations and the data centres involved in the SeismoSAT project is illustrated in Figure 2.

Figure 1 - Map of seismic stations in red and data centres in blue involved in the SeismoSAT project.

Table 1 shows average data link bandwidth required by the seismic stations involved in the SeismoSAT project. The bandwidth has been measured with the “orbstat” program of the Antelope software suite (BRTT Antelope software, 1995). It collects data on bandwidth required by each acquisition channels of a seismic stations by multiplying the number of packets received per second by each channel per the packet size. The average is done over the period since the last software reboot: in this specific case over a period of over 3 months.

Institute	Station code	Station name	Bandwidth (Kb/s)
OGS	ACOM	Acomizza	2,4
OGS	AGOR	Agordo	2,1
OGS	BALD	Monte Baldo	2,9
OGS	CGRP	Cima Grappa	2,4
OGS	CIMO	Cimolais	1,8
OGS	CLUD	Cludinico	2,4
OGS	DRE	Drenchia	3,0
OGS	FUSE	Fusea	2,9

OGS	MARN	Marana	3,5
OGS	MPRI	Monte Prat	2,7
OGS	PRED	Cave del Predil	3,3
OGS	SABO	Mt. Sabotino	2,7
OGS	VARN	Col Varnada	2,8
OGS	VINO	Villanova	1,7
OGS	ZOU2	Zouf Plan	2,4
ZAMG	ABTA	Abfaltersbach	2,7
ZAMG	ARSA	Arzberg	1,2
ZAMG	DAVA	Damuels	1,5
ZAMG	FETA	Feichten	2,4
ZAMG	KBA	Koelnbreinsperre	1,5
ZAMG	MOA	Molln	1,2
ZAMG	MYKA	Terra Mystika	2,4
ZAMG	OBKA	Obir,Austria	2,5
ZAMG	RETA	Reutte	2,6
ZAMG	SOKA	Soboth	2,5
ZAMG	WTTA	Wattenberg	1,8
PCBZ	ABSI	Aberstükl	2,8
PCBZ	BOSI	Bozen/ZS Zentrale	4,0
PCBZ	KOSI	Kohlern/Titschen	2,7
PCBZ	MOSI	Großmontoni/Vinschgau	2,7
PCBZ	RISI	Rein in Taufers/Ahrntal	2,6

PCBZ	ROSI	Roßkopf/Sterzing	2,6

Table 1 - Station list of Figure 2 with bandwidth in Kbit/sec.

The average bandwidth of station list indicated in Table 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. Variability in bandwidth required in Table 1 comes from different acquisition systems with different format/protocol used, different number of sensor used (only seismometer or seismometer coupled with accelerometer), various site quietness. As an example, station MOA and ARSA are very quite stations equipped only with seismometers (3 channels), while on the other side station BOSI is equipped with 2 sensors (6 channels) in a very noisy city environment.
In order to accomplish enough bandwidth for transmitting seismic data also in extraordinary conditions during a large earthquake, we fixed a bandwidth requirement of 8 Kbit/sec per each seismic station. As an example, Steim compression level 1 basically guarantee a compression of a factor of 4 between full range and quite conditions by using first-differences 1 byte in quite conditions instead of 2 or 4 bytes in noisy conditions (SEED Reference Manual Version 2.4).
Total bandwidths required per network are then:

- OGS 120 Kbit/sec
- ZAMG 88 Kbit/sec
- PCBZ 48 Kbit/sec

Each data centre has to upload to the satellite network 2 copies of its network data, one for each of the other 2 data centres.
Total upload bandwidths required are therefore:

- OGS 240 Kbit/sec
- ZAMG 176 Kbit/sec
- PCBZ 96 Kbit/sec

While download bandwidths 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

PROJECT SCHEMATIC

The project schematic is illustrated in Figure 3, with the total data bandwidth requirements per data centres.

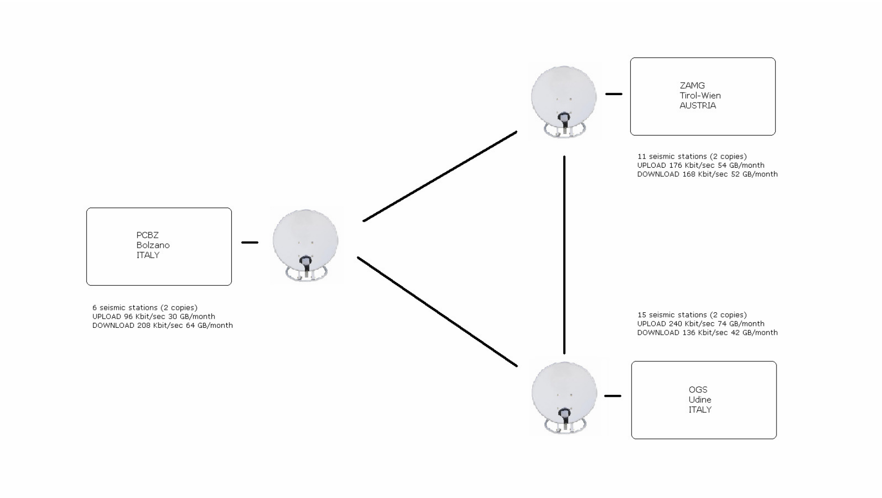

Figure 1 - SeismoSAT schematic diagram with data bandwidth requirements.

The Antelope software suite has the capability to exchange data in real time among data centres: 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. A more sophisticated version of this data exchange module is the software module 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.
Alternatively the automatic switching between the default internet and the back-up satellite data links could be done with a VPN. For this reason tests are undergoing with the Cisco 2921 router with VPN capabilities.
As the satellite provider, a new Eutelsat KA-BA satellite terminal has been selected and will soon be tested (Fig.4). Its main characteristics are:

- max.18432kbit/s download, 6144kbit/s upload
- 1 public IP address and 60GB data volume
- Annual link availability: >99,5%
- RTTs Satellite round trip time: < 600 ms
- Data Interface: Lan/Ethernet
- Security: Time Division Multiple Access (TDMA)

– Modulation: 16-APSK

It is currently the best choice in Europe for internet via satellite with data volumes like the SeismoSAT project with good technical support in the Interreg area.

Figure 4 – Eutelsat KA-BA terminal and antenna from SOSAT.

CONCLUSIONS

Project architecture and technical and bandwidth requirements have been set. Hardware has been selected and purchased. The SeismoSAT project is currently in testing phase.

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