Venice Office
Regional Bureau for Science and Culture in Europe
United Nations Educational, Scientific and Cultural Organization

International School and Workshop
Nonlinear Mathematical Physics and Natural Hazards
Nov.28-Dec.2, 2013, Sofia, Bulgarian Academy of Sciences

BULGARIAN ACADEMY of SCIENCES 1869

SEENET-MTP
Southeastern European Network in Mathematical and Theoretical Physics
www.seenet-mtp.info

INRNE

Romanian-Bulgarian

Early Warning System (EWS)

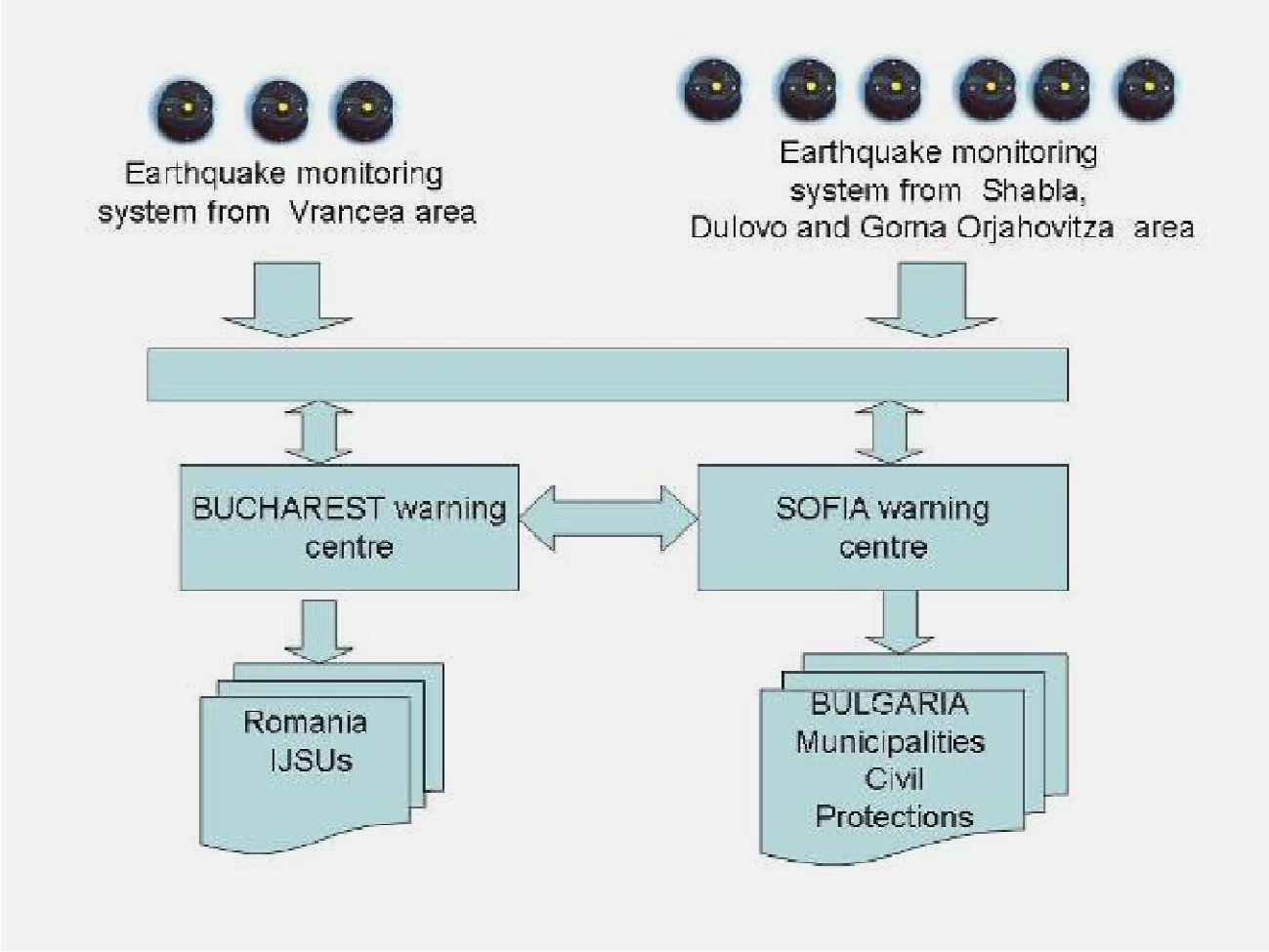
developed for cross-border area

results of DACEA CBC Project

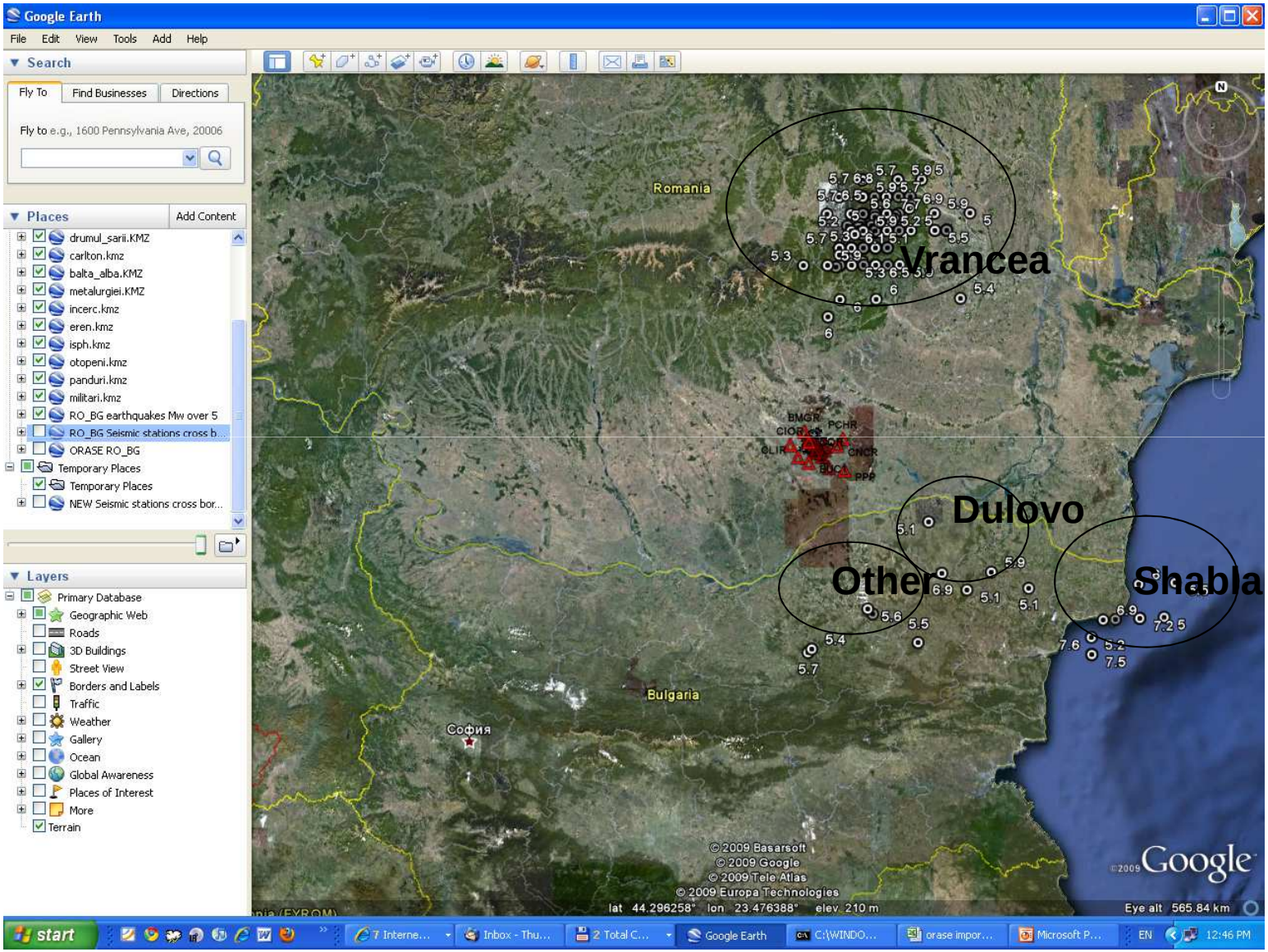
Project Area

Romania: Mehedinti, Dolj, Olt, Teleorman, Giurgiu, Calarasi, Constanta;
Bulgaria: Vidin, Vratsa, Montana, Pleven, Veliko Tarnovo, Ruse, Silistra, Dobrich si Razgrad

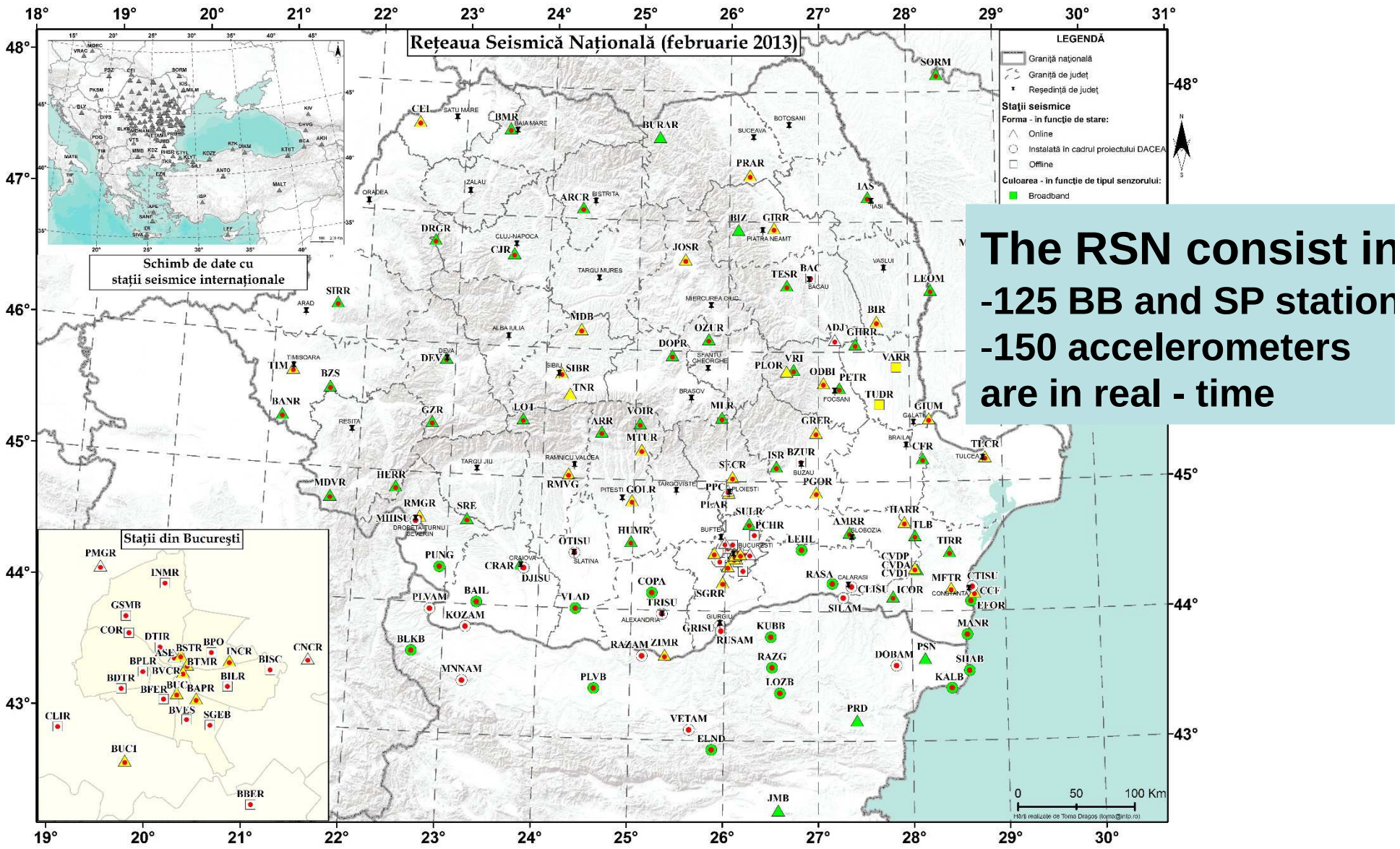
Real time acquisition and the data flow diagram



SELECTED ACTIVE SEISMIC ZONES



ROMANIAN SEISMIC NETWORK + SEISMIC STATIONS IN CROSS BORDER AREA



NEW SEISMIC STATIONS in CROSS BORDER AREA

PURPOSE
- cover all active seismic zones
- quick estimate of earthquake parameters, intensities, damage

Seismic station instalation

EFOR-Eforie Nord

BAIL - Bailesti

SHAB - Shabla

CONFIGURATION of Seismic stations

- A backup power supply system
- 24-bit digitizer with GPS (Q330 manufactured by Kinemetrics)
- ES-T type sensor three components
- STS2 broadband sensor
- Digital accelerometers for PGA

EVOLUTION OF RAPID EARLY WARNING SYSTEM IN ROMANIA (REWS)

1980-1982 – Installation of telemetry seismic network composed adin 18 seismic stations; - First alarm for duty staff using speaker

1997- First publication and patent of REWS

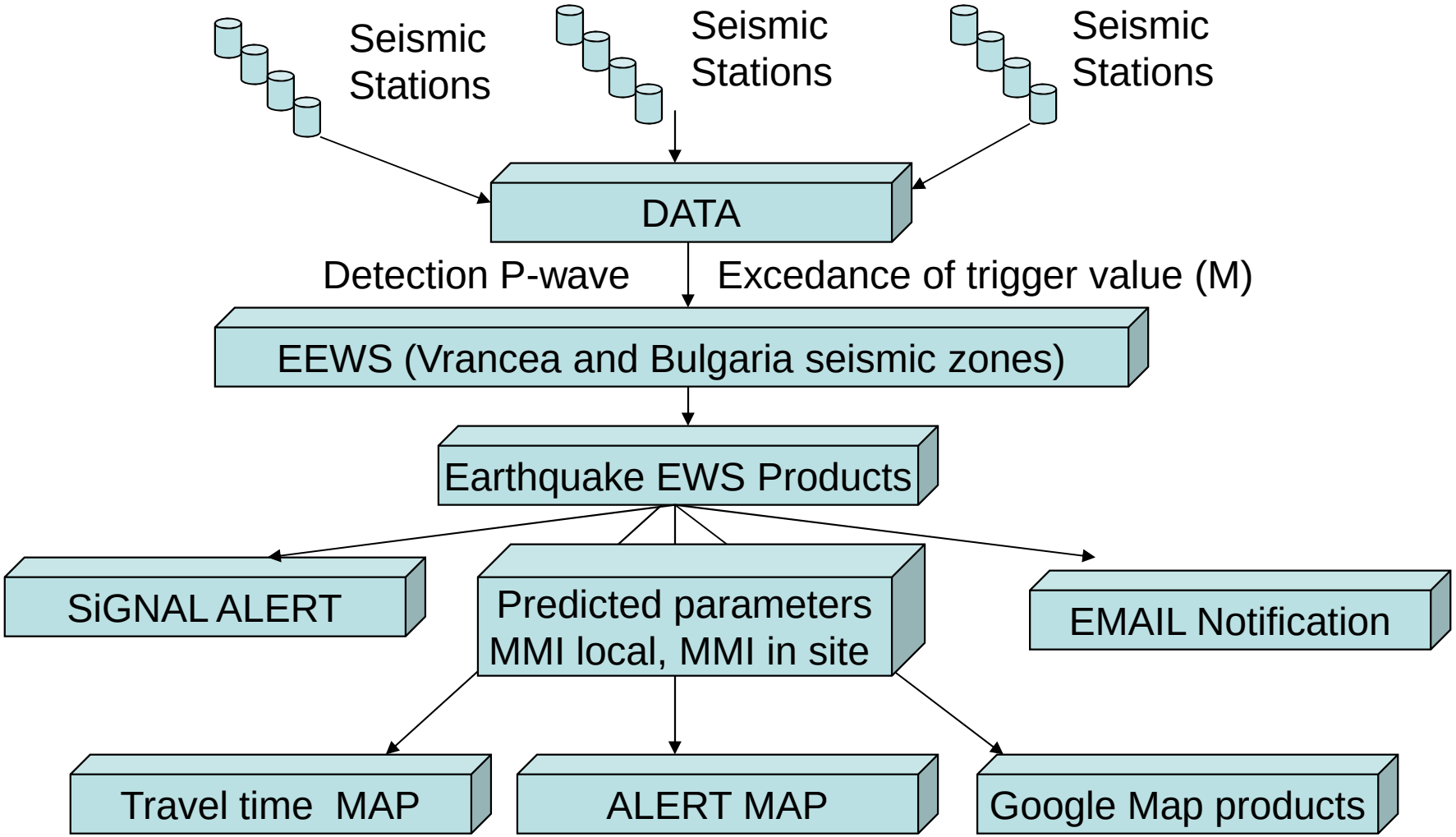
2000 - The first alarm system in partnership

2004 - REWS for dangerous facilities

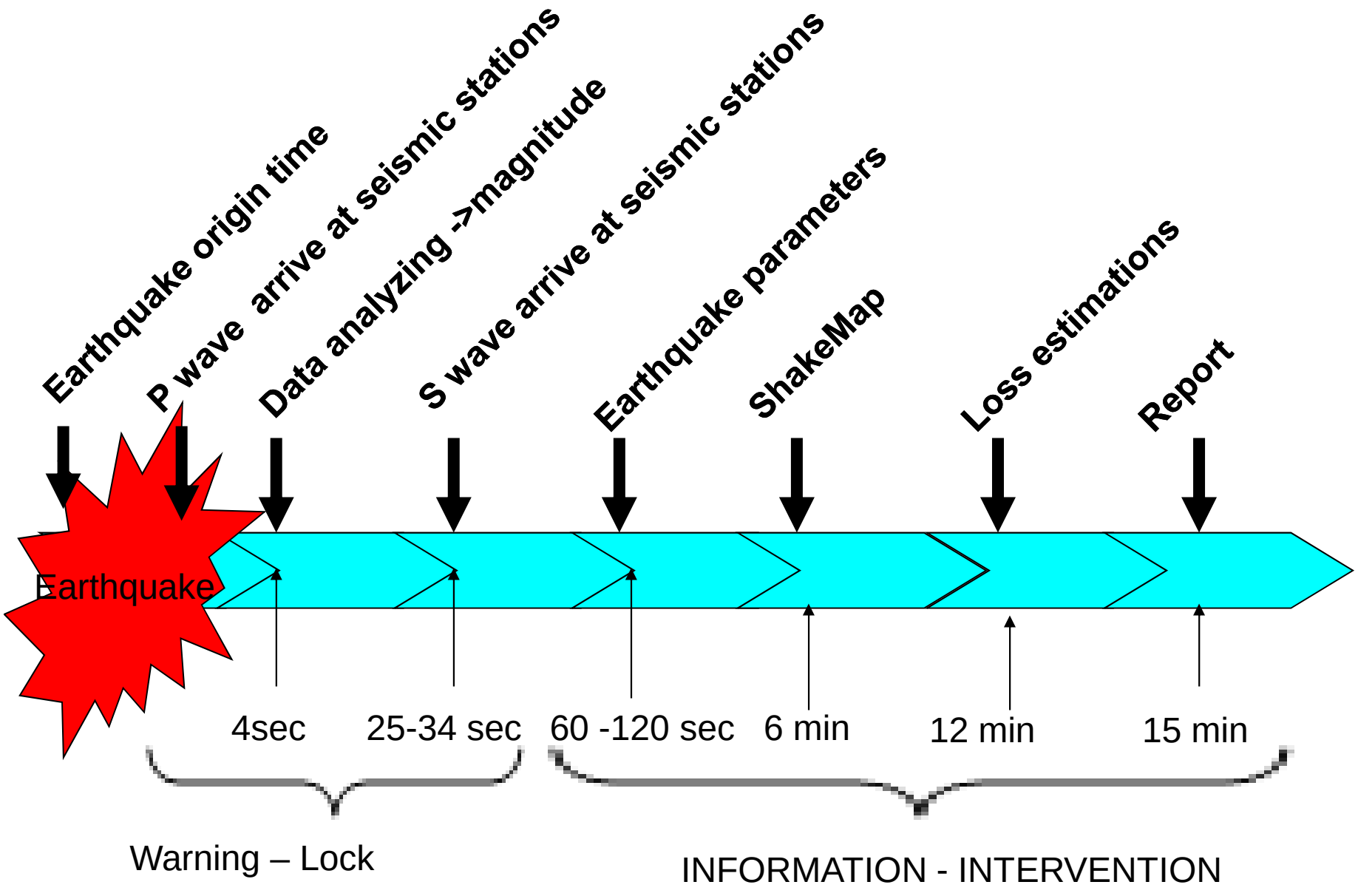
2007 – REWS for nuclear facilities using PGA at two stations from 3

2011
2013 } DAnube Cross-border system for Earthquakes Alert

Diagram for Eartquakes EWS

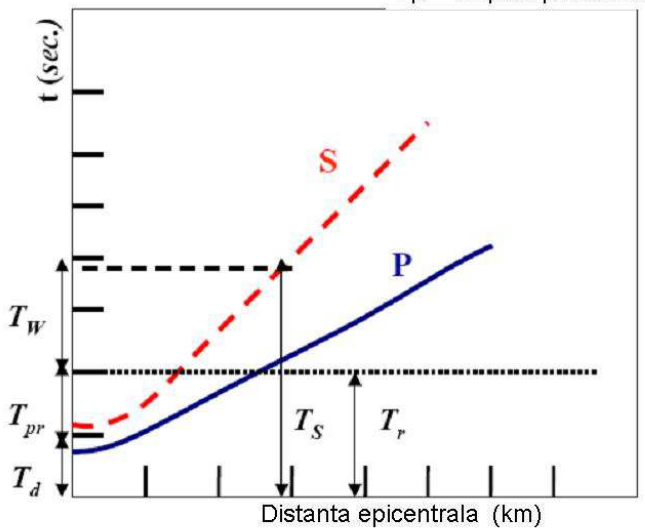


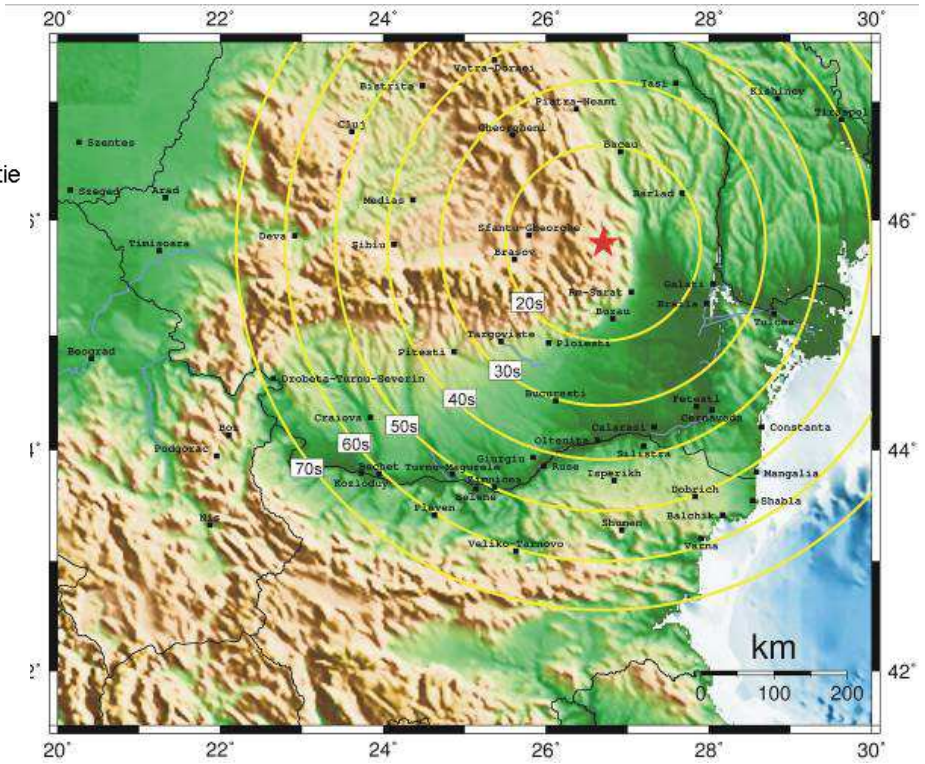
REWS timeline



TIME of Vrancea eathquake alert

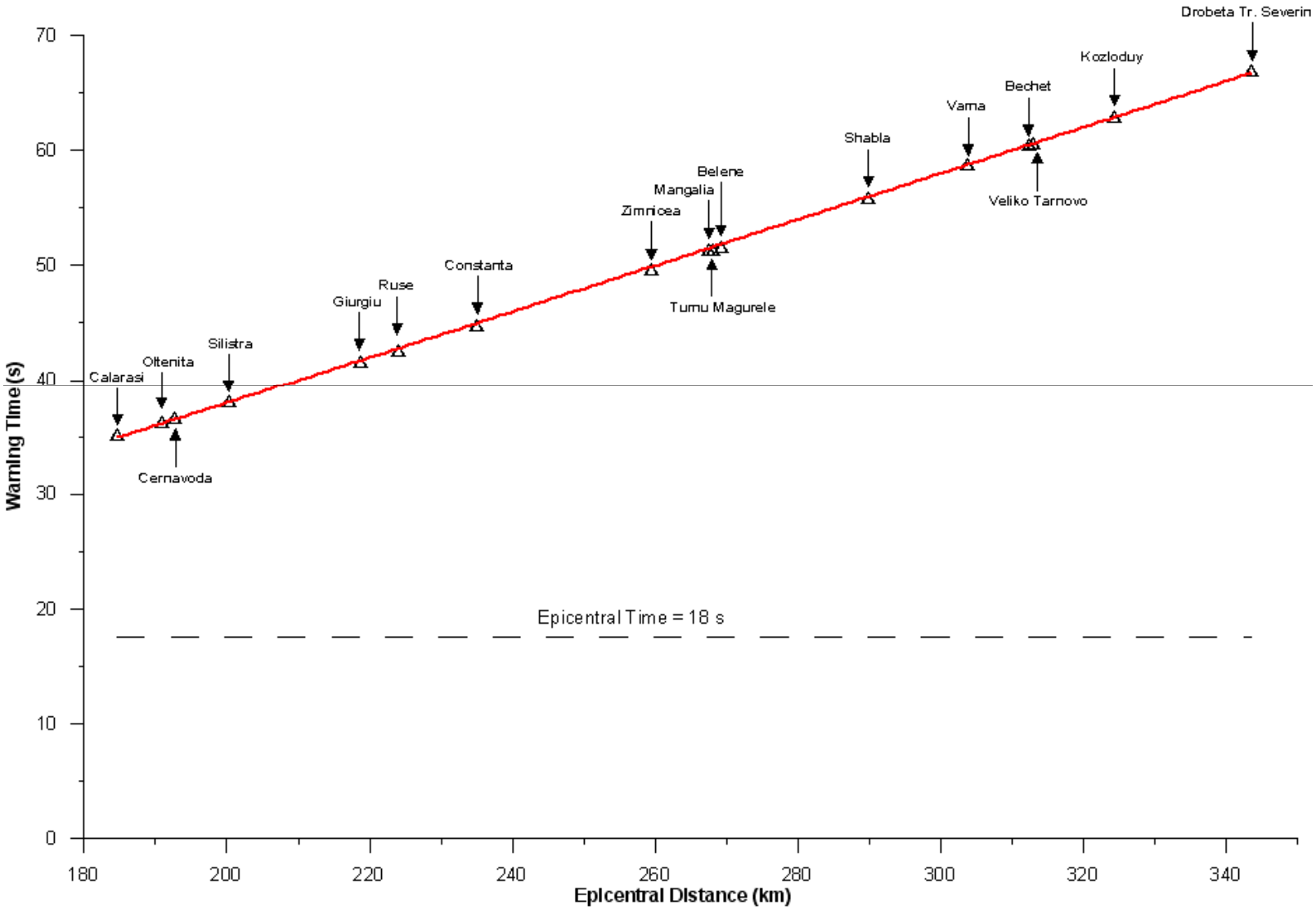
Tw=Ts-Tr
Tr=Td+Tpr
Tw = timp de alarmare
Ts-=timp cand unda S ajunge in site
Td= timp necesar sistemului pentru detectie
Tpr= timp de procesare



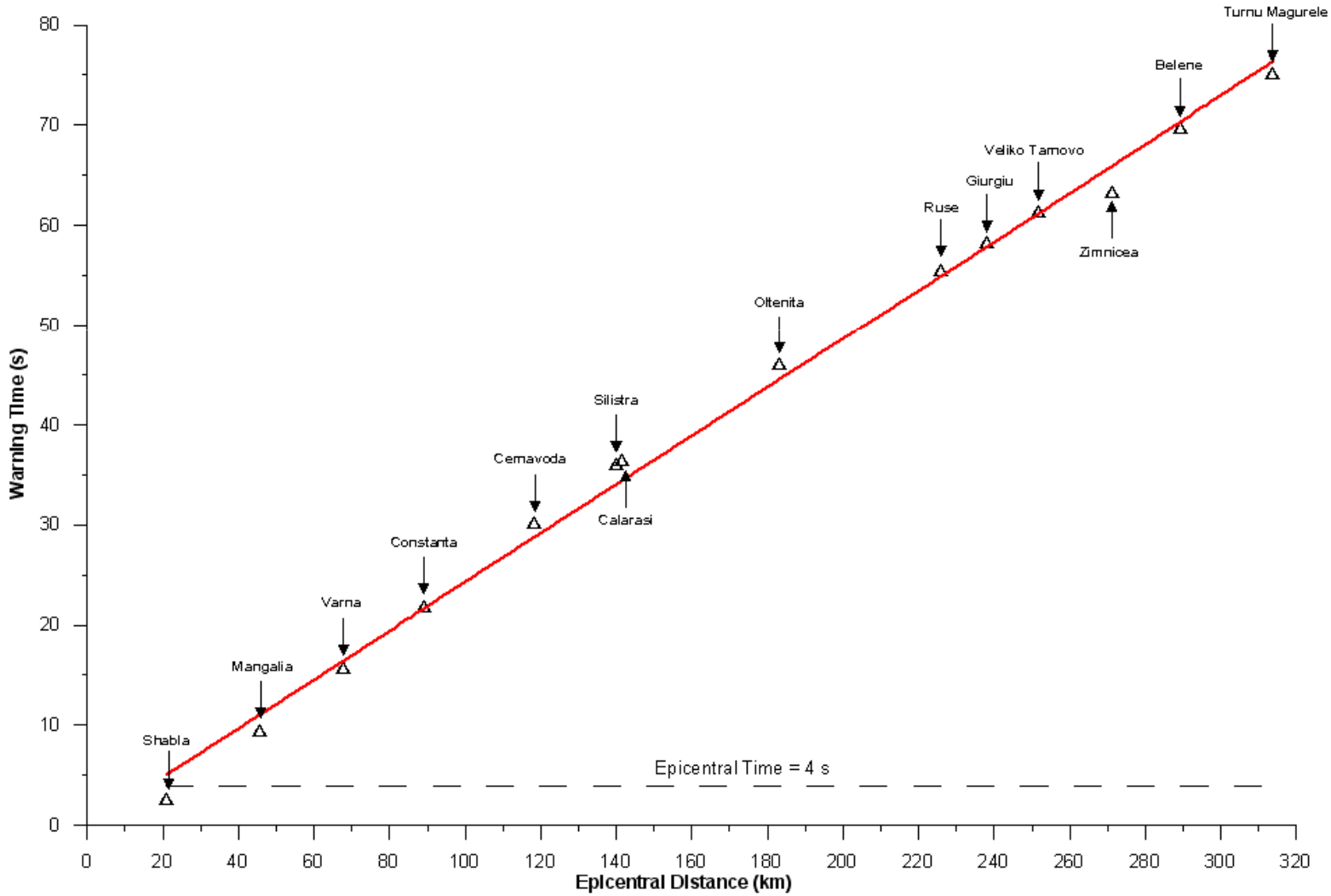


EWS is based on the difference between velocity of S & P seismic waves and data transmission speed. Usually it is a time period ranging from several seconds to a minute.

Theoretical warning time for a major earthquake which occcurs in Vrancea at 130km depth

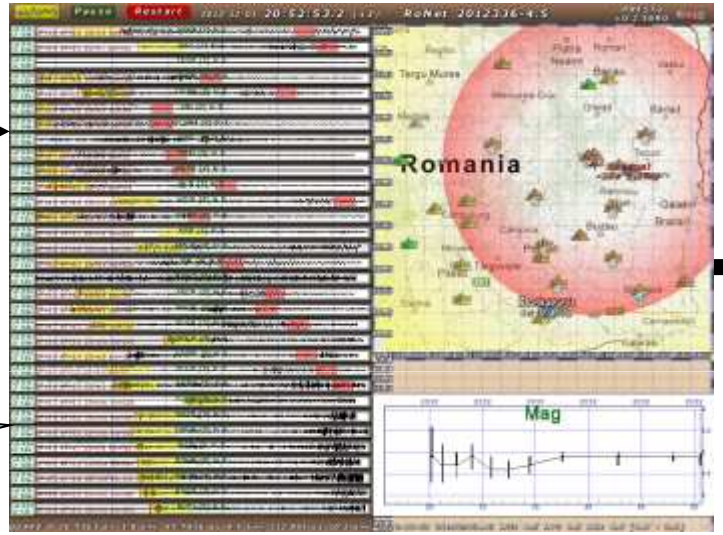


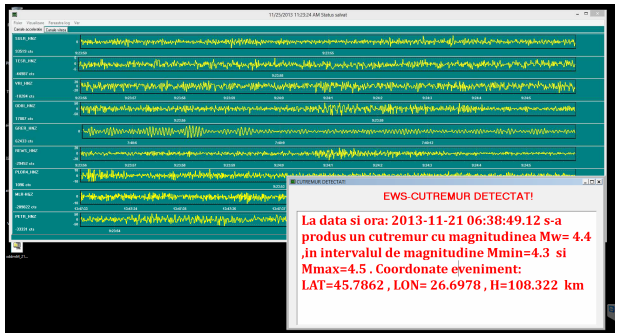
Theoretical warning time for a major earthquake which occcurs in Shabla seismogenic zone (h=10km)



ELEMENTS OF THE RAPID SEISMIC WARNING SYSTEM

Seismic stations





Validation system

Know how

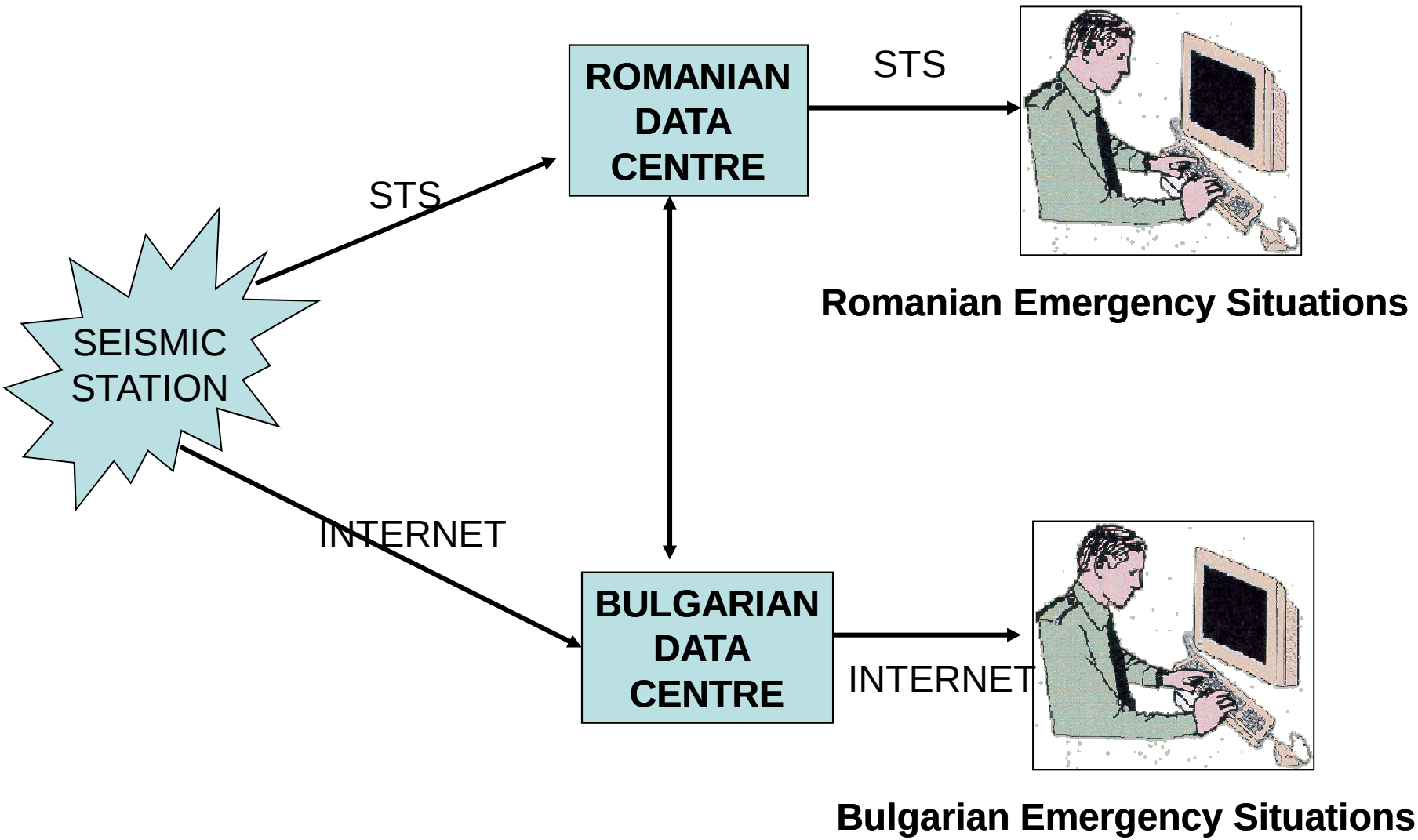
25-40 sec. before the s wave

SMS
E-MAIL

Procedures to be followed in case of a large earthquake occurrence

EDUCATION!!!

DATA COMUNICATION



Earthquake EWS type of messages

- Sound - via TETRA, SMS, RDS/TMC, TCP/IP
- Text – “In the next 24 seconds following an earthquake with M = 6.5” - via TETRA, SMS, RDS/TMC, TCP/IP

Model of TCP_IP device
- **static Ip**
- **internet, intranet connection**

Model of RDS device
- **Radio network**

TETRA device

SMS

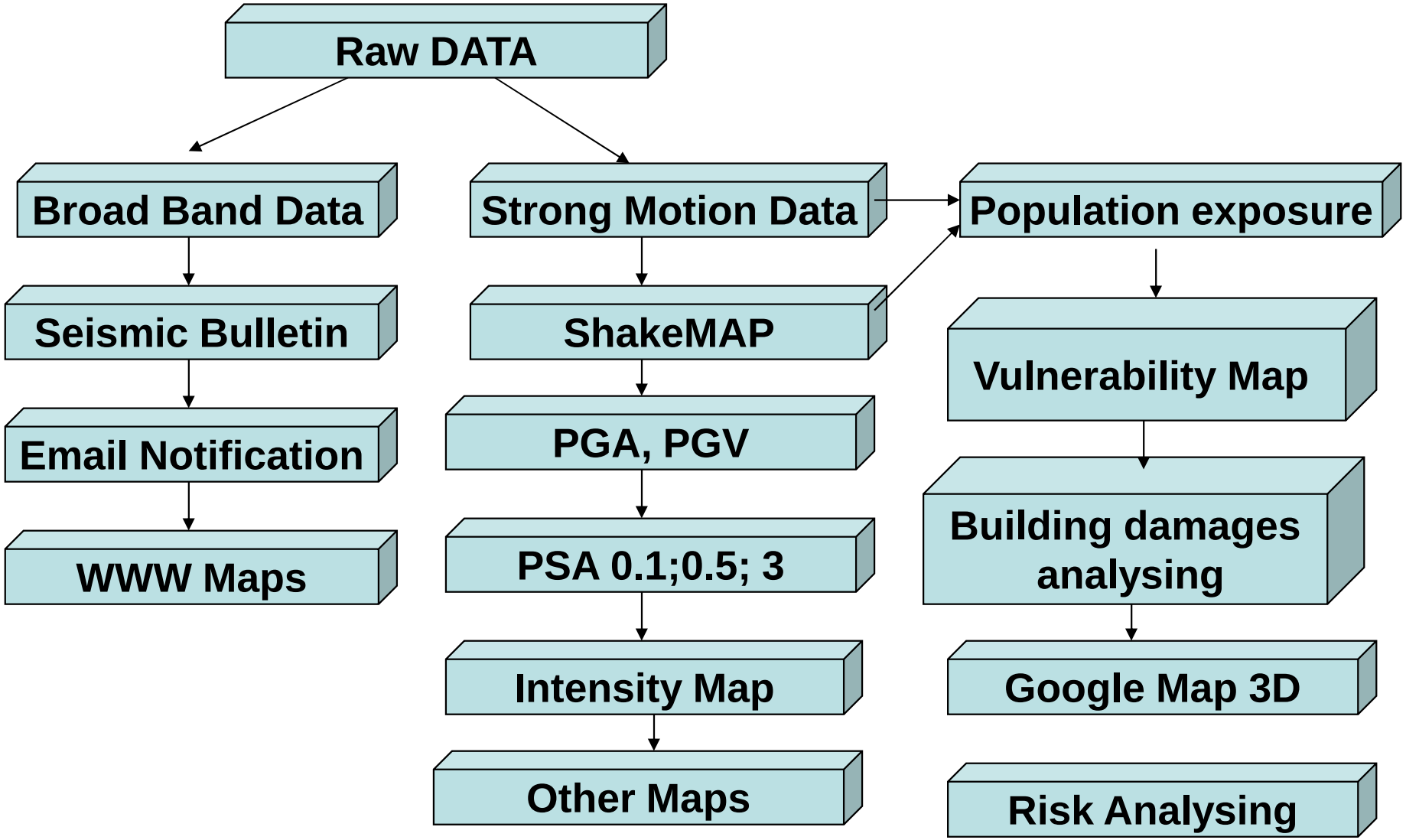
Equipments at RO & BG inspectorates for emergency situations

CALARASI

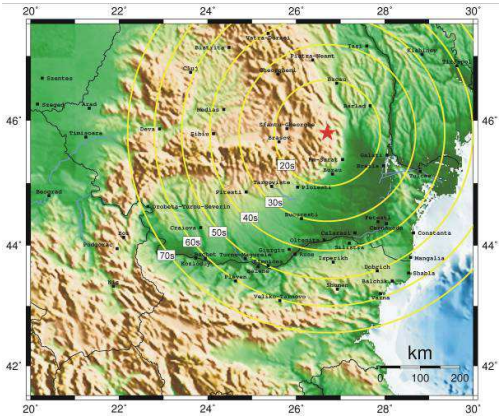
DOBRICH

SILISTRA

Earthquakes parameters, ShakeMap, Pager ShakeCAST and Risk analysing

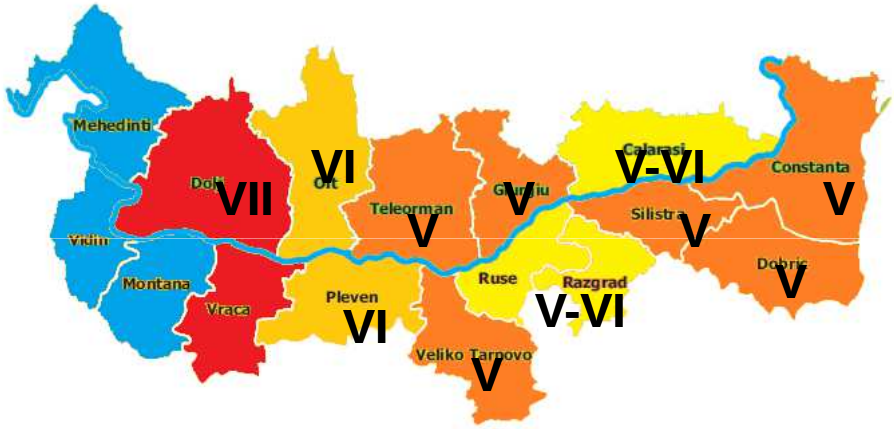


Earthquake Early Warning System type of products example



P and S wave Travel time

Products accesible until S wave arrive in site.



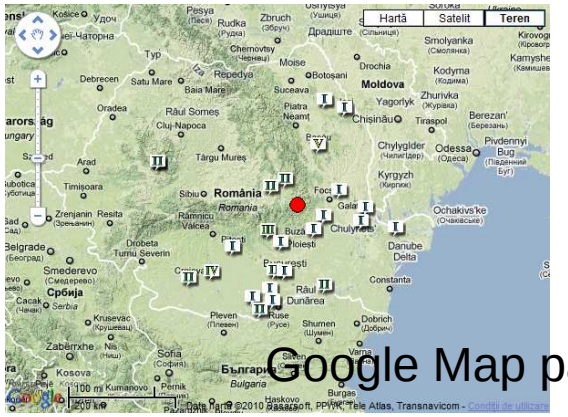
Predicted Alert Map

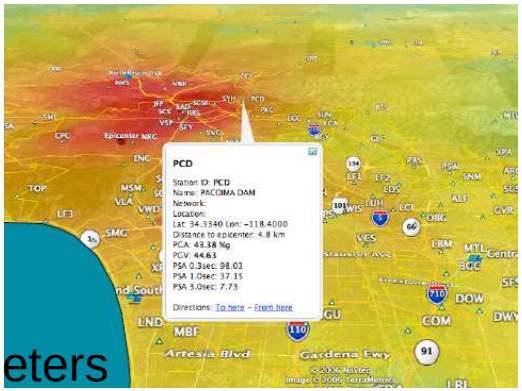
Time Alert

Ex. Vrancea eq.
30 seconds before S Wave arrive in site

Users

IES, CP, CJ, Infrastr. Municipatities





Google Map parameters

Types of alert mesages

1. July 8, 2009 at 19:31:21 (GMT) an earthquake occurred in the …….. region of magnitude ……at depth of 90 km, I = VII, 50 km from Sulina , 40 km Vrancioaia, 40 km Odobesti –

Acceleration values at different points, the intensity values.

PRODUCTS via PORTAL

ShakeMap, PGA, PGV maps, Damage estimation, Maps and table of damages, MMI using questionary, Pictures with damages.

SEISMIC BULETIN

Alert ro_ndc2011uxdm: determined by 8 stations, type A

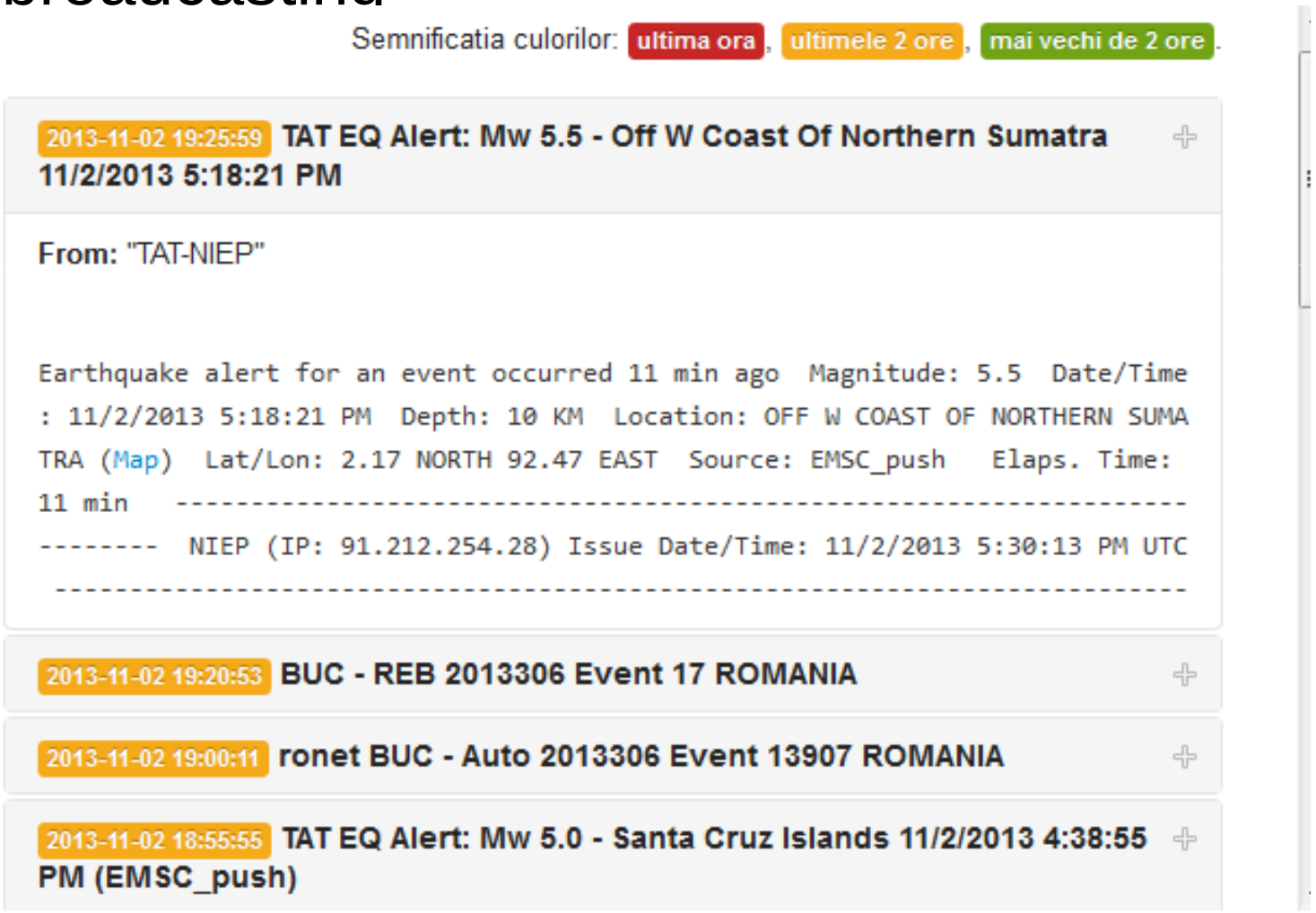
LOCSAT solution with earthmodel iasp91 (with start solution, 8 stations used, weight 8):
Turkey-Iran Border Region mb=4.2 2011/10/25 06:36:23.6 38.90 N 44.50 E 74 km

Stat	Net	Date	Time	Amp	Per	Res	Dist	Az	mb	ML	mB
KTUT	KO	11/10/25	06:37:24.9	0.0	0.0	-0.0	4.2	301	0.0	4.6	0.0
TESR	RO	11/10/25	06:39:55.2	19.7	1.3	2.0	15.1	306	4.3	0.0	0.0
DOPR	RO	11/10/25	06:39:59.7	49.9	1.0	-1.2	15.7	303	4.8	0.0	0.0
VOIR	RO	11/10/25	06:40:02.9	14.5	1.0	1.3	15.8	301	4.2	0.0	0.0
BUR32	RO	11/10/25	06:40:08.2	25.5	0.9	-2.2	16.5	308	4.5	0.0	0.0
VTS	MN	11/10/25	06:40:10.3	8.7	1.1	-0.5	16.5	290	4.0	0.0	0.0
TRPA	HU	11/10/25	06:40:32.2	1.2	1.1	0.2	18.3	307	3.1	0.0	0.0
PSZ	GE	11/10/25	06:40:49.8	13.3	1.3	0.4	19.9	305	4.1	0.0	0.0

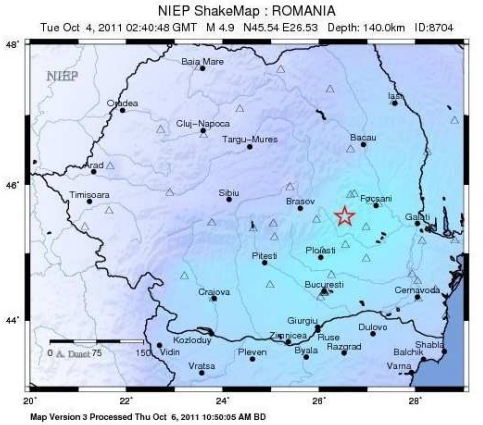
RMS-ERR: 1.25
First location: 2011/10/25 06:28:20
This location: 2011/10/25 06:28:20

Alerts

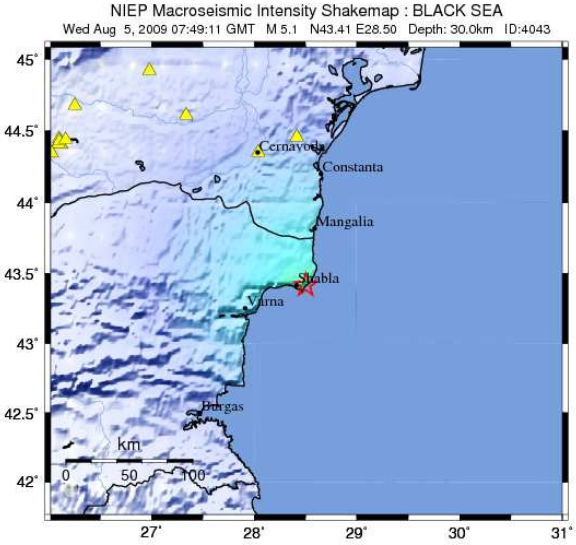
- TETRA, SMS, TCP/IP
- Internet broadcasting



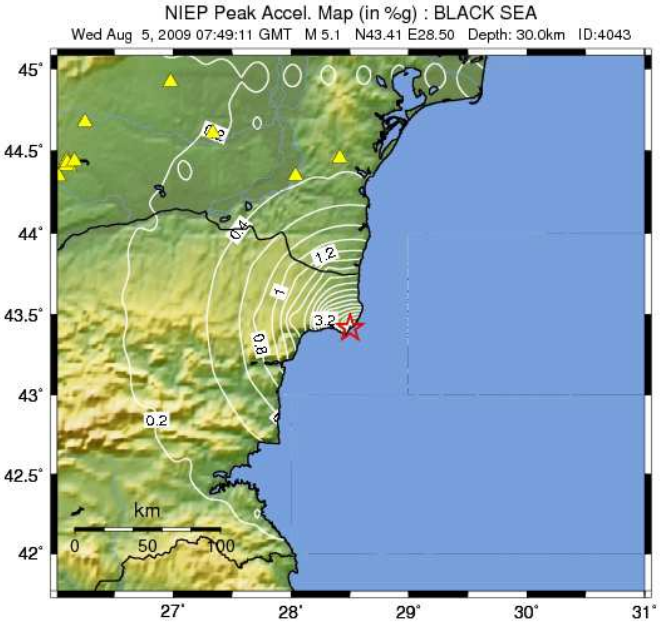
ShakeMap



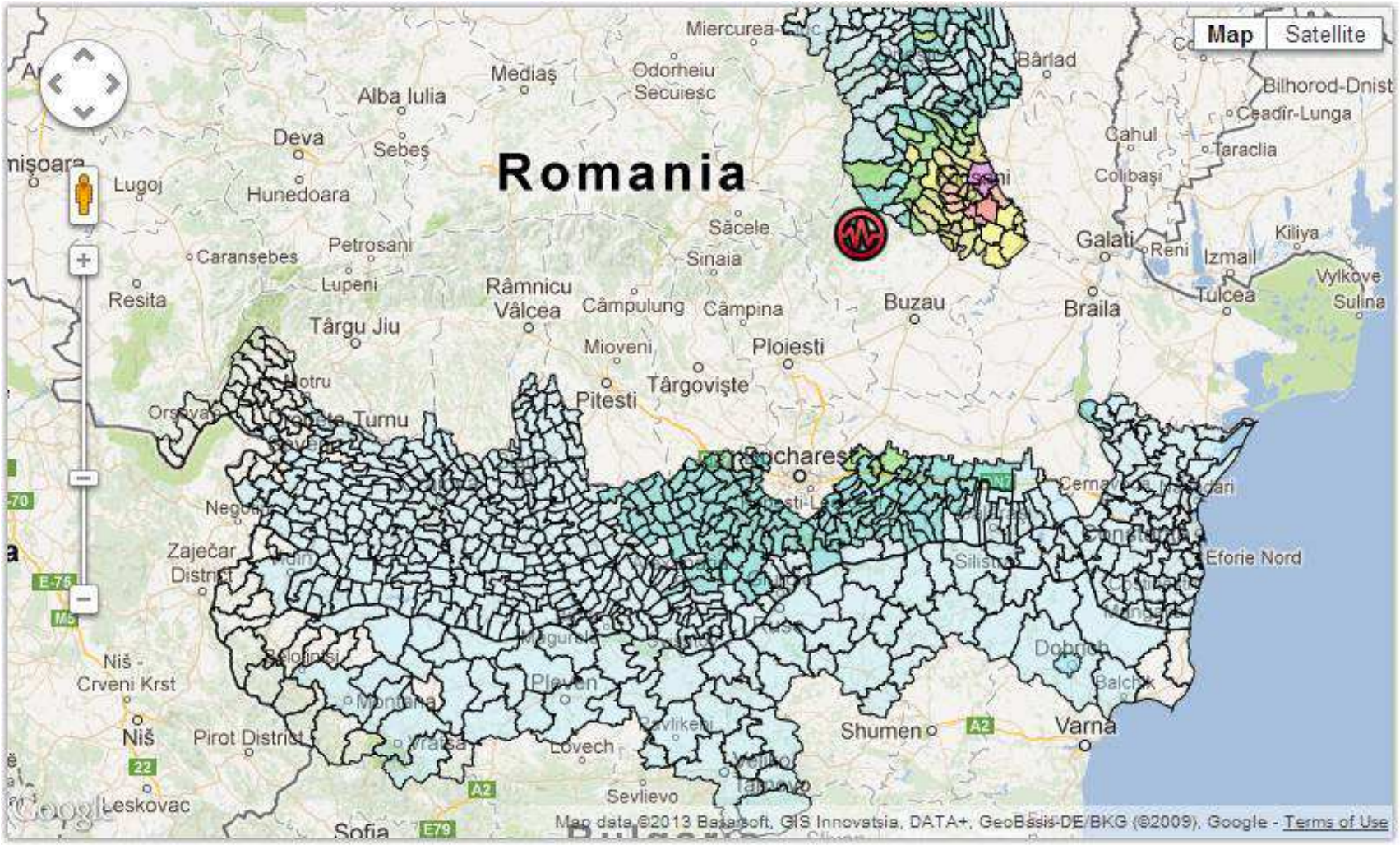
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	*8.1-16*	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+



Estimates of the vulnerability of buildings scenario earthquake VR1986



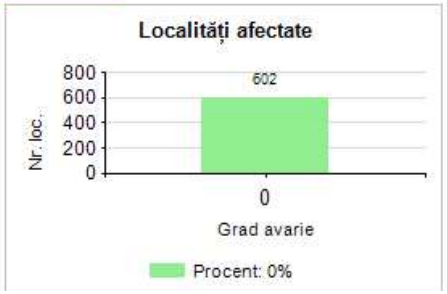
FIRST REPORT

Id eveniment:	11798	Latitudine (grade):	45.4939
Data si ora:	27.02.2013 14:30:00	Longitudine (grade):	24.3159
Magnitudine:	4.00	Regiune:	ROMANIA
Adancime (km):	5.00	Judeţ:	Vâlcea

EARTHQUAKE REPORT

Id eveniment:	11798	Data si ora:	27.02.2013 14:30:00
Latitudine (grade):	45.4939	Longitudine (grade):	24.3159
Magnitudine:	4.00	Adancime (km):	5.00
Regiune:	ROMANIA	Județ:	Vâlcea

Procent: 0%



Neavariat

Populația estimată expusă la cutremur:

Nr. pop. (k = x 1000)	23,039.51k	17.13k	0	0	0	0	0	0	0
MMI	**I**	**II - III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X+**
Cutremur resimțit	Nu este simțit	Slab	Ușor	Moderat	Puternic	Foarte puternic	Sever	Violent	Extrem
Structuri rezistente	Fără avarii	Fără avarii	Fără avarii	Foarte ușoare	Ușoare	Moderate	Moderate / Mari	Mari	Foarte mari
Structuri vulnerabile	Fără avarii	Fără avarii	Fără avarii	Ușoare	Moderate	Moderate / Mari	Mari	Foarte mari	Foarte mari

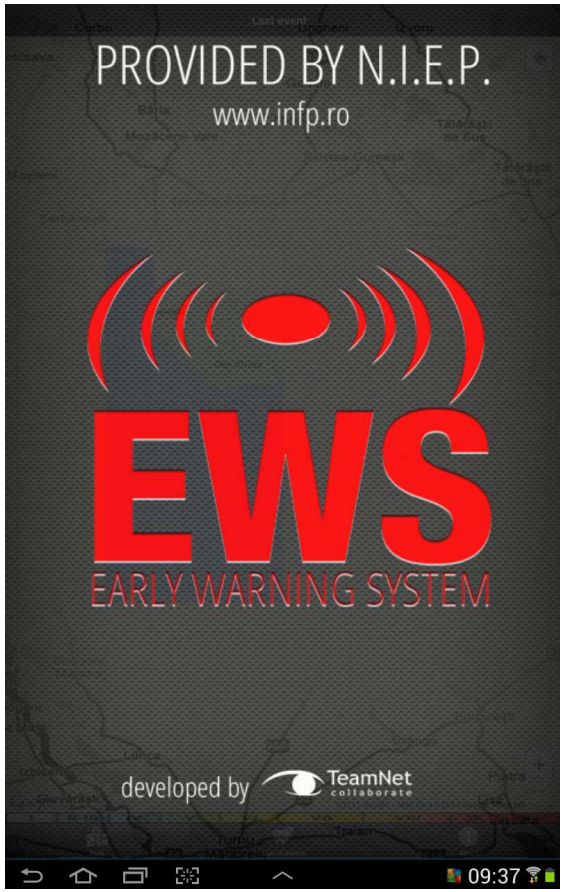
Ultimele cutremure din regiune:

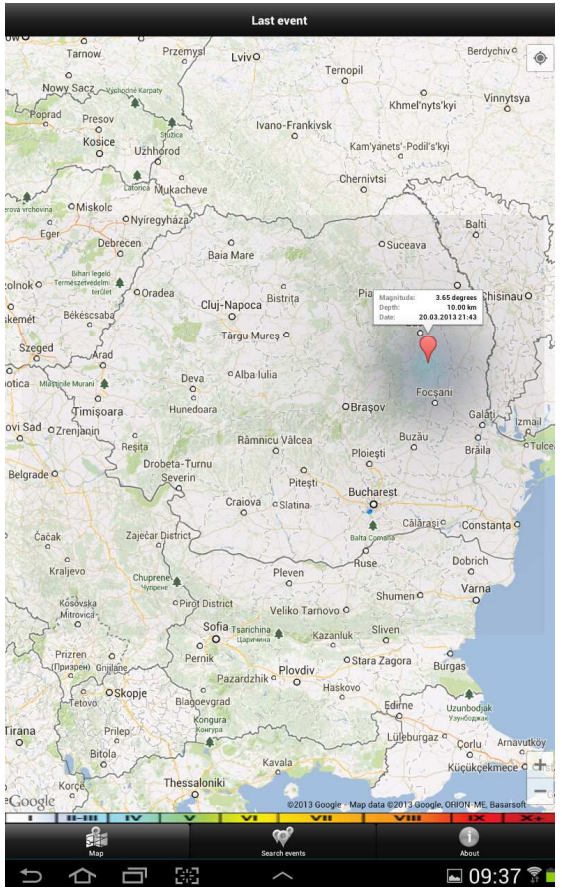
Dată	Adâncime	Mag.	MMI max.
22.02.2013	15.00	3.10	III
10.02.2013	120.00	3.40	II
30.01.2013	70.00	3.00	II

Orașe apropiate:

Curtea de Argeș(49Km); Sibiu(35Km); Râmnicu Vâlcea(45Km);

MOBILE APLICATION





RAPID Early Warning System