PROTEZIONE CIVILE
Presidenza del Consiglio dei Ministri
Dipartimento della Protezione Civile

www.protezionecivile.gov.it

Meeting:

ANTELOPE USER GROUP

DPC headquarters – via Vitorchiano 2-4 – Rome - Italy

May 18th to 20th , 2016

Seismic Monitoring in Italy by the Civil Protection Dept. (DPC)

Mario Nicoletti (DPC)

mario.nicoletti@protezionecivile.it

www.protezionecivile.gov.it

https://RAN.protezionecivile.it *www.mot1.it/OSSdownload*

Ground Motion Monitoring: General Objectives and Synergies

Seismic monitoring contributes to DPC's goals of:

- **making more effective the delivery of emergency response services,**
- **improving the evaluation, prevention and mitigation of the seismic risk.**

The co-operation of regional and municipal governments is sought.

They provide sites and structures to be monitored and participate to temporary monitoring campaigns, while DPC provides project managing and funding, and shares data.

DPC's strategy for Seismic Monitoring

The seismic monitoring strategy of DPC is based on the following activities:

1) **Seismic surveillance → INGV-CNT** (mostly velocimeters)
2) **Ground motion monitoring → DPC-RAN** (accelerometers)
   - Permanent network
   - Mobile network (10 more stations in epicentral area)
3) **Structure monitoring → DPC-OSS** (mostly accelerometers)
   - Regular permanent network
   - Simplified permanent network
   - Mobile network (4 more monitoring systems in ep.area)

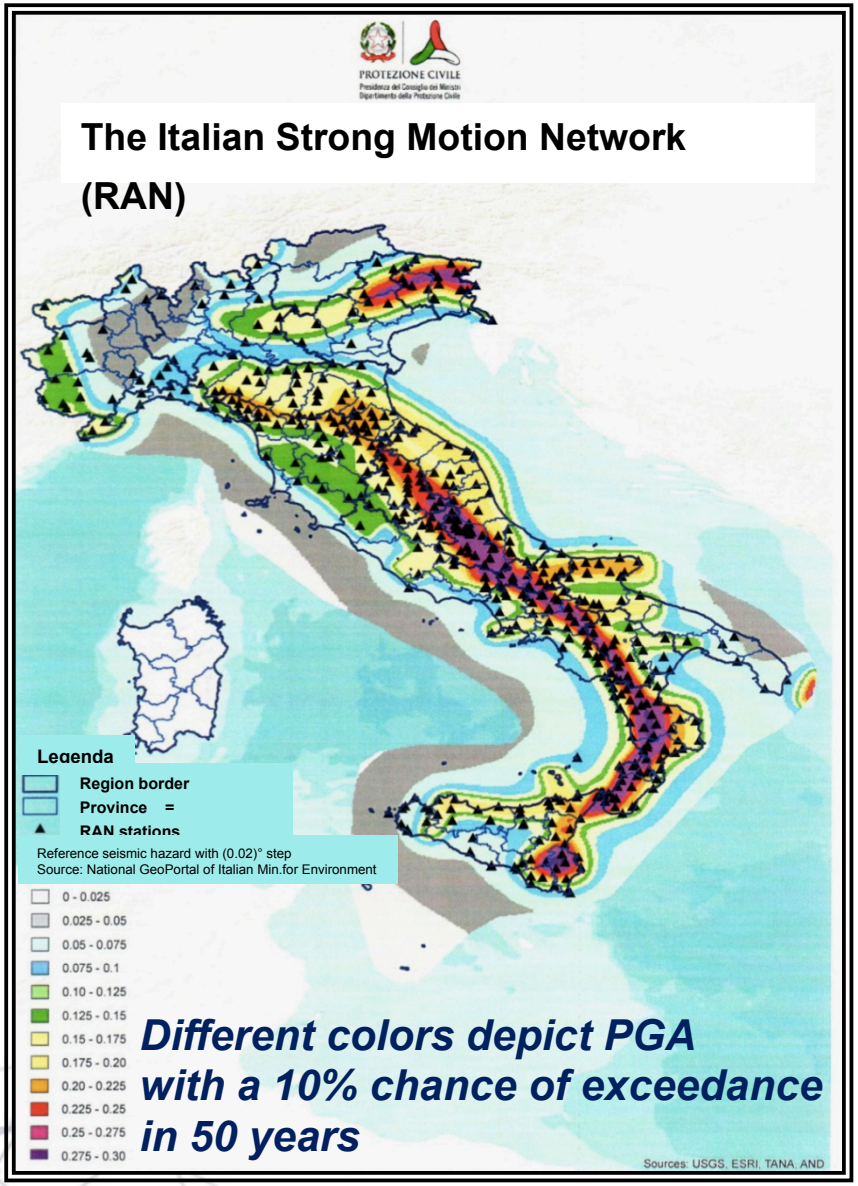
DPC strong motion monitoring by RAN&OSS integrates information from INGV with a detailed description of ground shaking and effects on constructions in epicentral area, needed for civil protection actions.

Seismic Surveillance: the RSN

The Italian National Seismic Network (RSN) is managed by INGV – CNT (National Institute of Geophysics and Volcanology – National Earthquake Centre).

By means of 292 velocimeters, it provides DPC with quasi-real-time information on location and magnitude of Italian earthquakes.

Ground Motion monitoring: the RAN



With 97% efficiency, the Italian Strong Motion Network (RAN) records earthquake strong motion accelerations on the ground by means of 580 stations:

A) 531 DPC-managed:

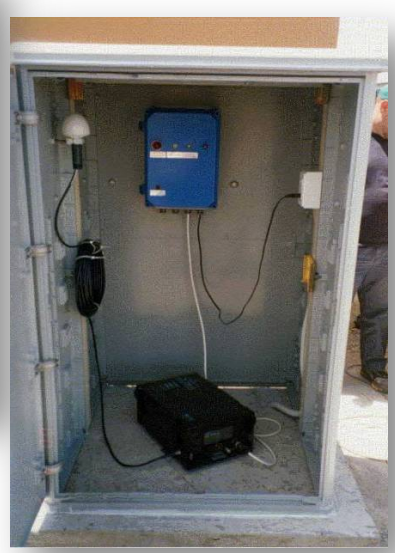
- 201 (DPC) inside ENEL electric transformation substations;
- 306 (DPC) mostly in free field;
- 19 (Calabria R.) = = ;
- 5 (Potenza P.) = = ;

B) 49 owner-managed:

- 31 (AMRA) in free field;
- 18 (UniTS) = = .

RAN stations

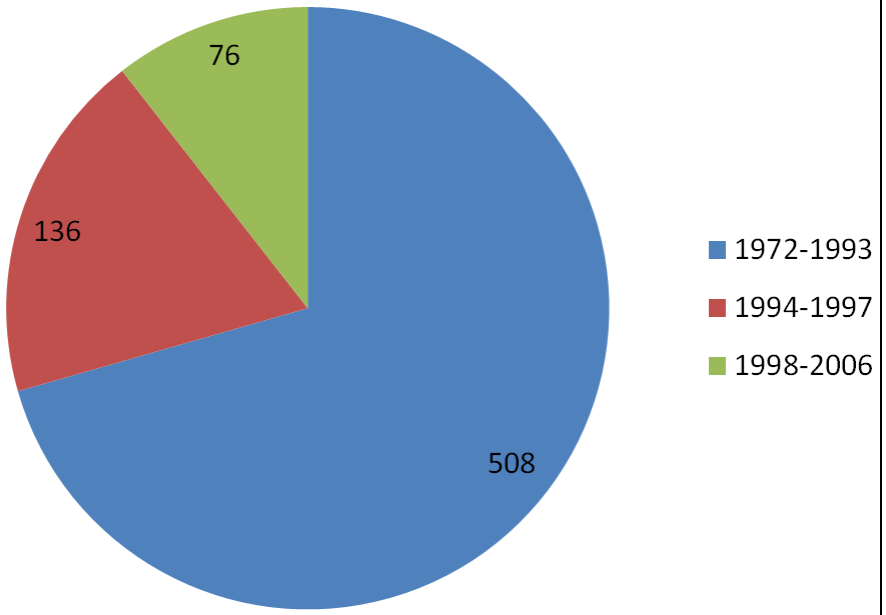
RAN 3-channel digital force-balance accelerometers record and transmit trig-gered data (continuous in 82 stations) with 18÷24 bit resolution in a range of ±1-2g, associated with GPS time.



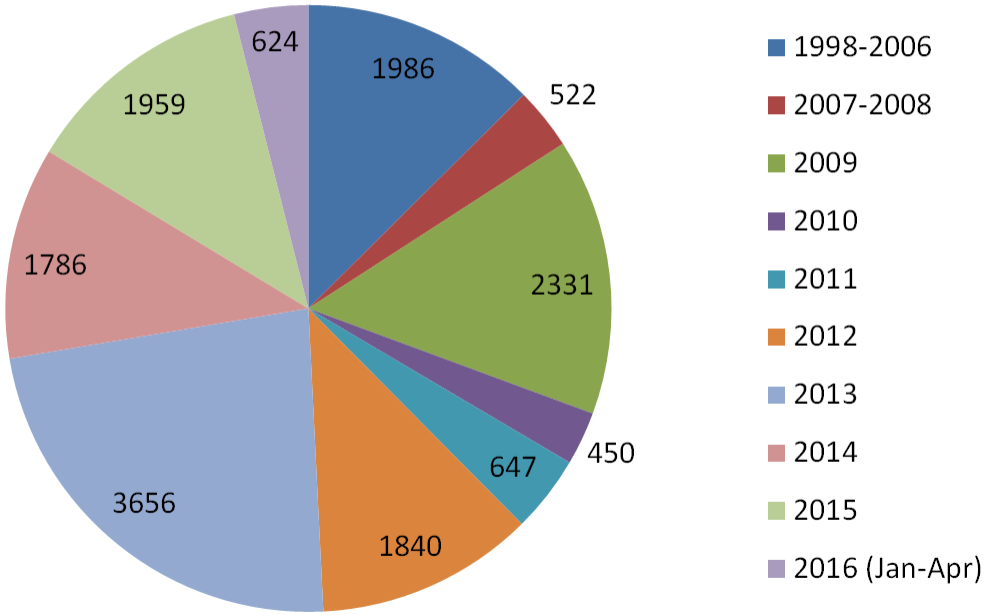
Through routers for the 3G network data reach RAN server in Rome, where shak-ing parameters and respon-se spectra are computed and shared via SMS (2'), e-mail (5') and through a dedicated website (19' after seism).

RAN archive

720 analogue recordings



15.801 digital recordings

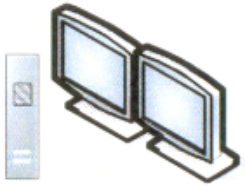


On May 1st, 2016 RAN archive included 16.521 tri-channel recordings: 720 analogue (*strong motion*) + 15.801 digital (most M>3 events with a minimum of 5 triggered stations).

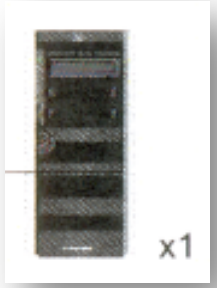
RAN central data acquisition system

2 x Dell PowerEdge R720 (2U) con:
- 2 x Intel Xeon E5-2690 3.30GHz 8-core CPU
- 128GB RAM
- 2 x 400GB SSD hot-plug drives in configurazione RAID1 (mirrored)
- Dual-port fiber-channel HBA
- Dual hot-plug redundant Power Supplies (configurazione 1+1)
- iDRAC7 Enterprise Management Controller

NexSan SATAbeast :
1TB @ 7200 HDD
2xiSCSI
2xFiber Channel port



4 x Dell OptiPlex 7010 con:
-Intel 3.4Ghz Dual-core CPU
-8GB RAM
-320GB SATA HDD
-DVD+/-RW SATA
-2 x Display ports
Le macchine sono fornite con cavi ed accessori necessari:
-**3** x **monitor 24"** LCD;
-5 x Display Port to DVI adapter

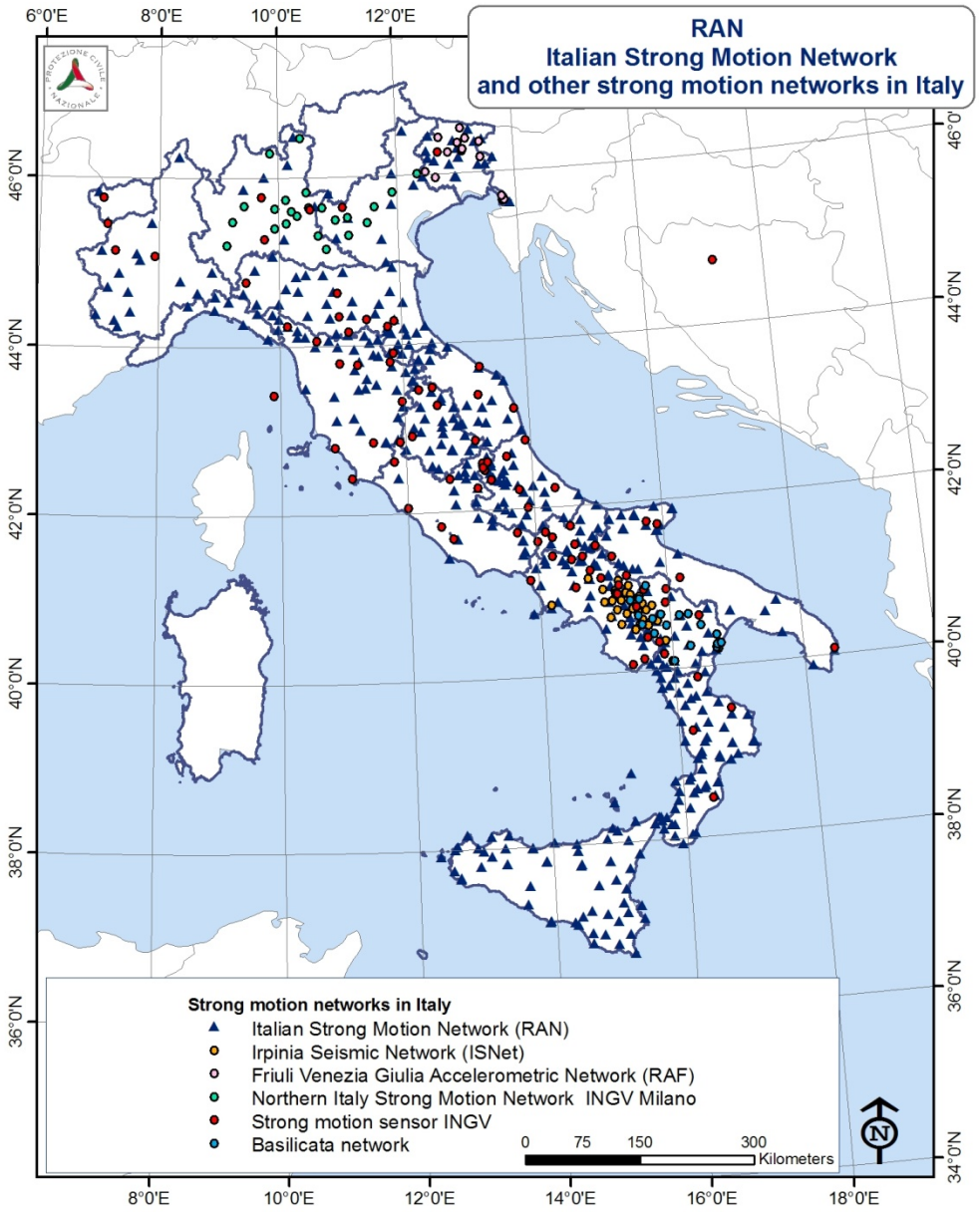


1 x **DELL PRECISION T3610 TOWER (**DISPLAY SERVER up 6 monitors**)** con:
3.7GHz Quad-core CPU
8GB RAM
500GB SATA HDD
DVD ROM SATA
1 x AMD FirePRO W600 Graphic cards (*6 miniDisplayPort*) 256MB

The HW/SW system installed in 2010 at DPC uses Antelope™ application to automatically receive, store and analyze data in near-real-time.

A general upgrade has been carried out in 2014, with full HW clusterisation to prevent system failure. Virtualization of RAN processes is foreseen in 2016-2017.

RAN 2016 envisaged developments



DPC new stations for RAN:

+ 10 stations to enhance coverage in the less instrumented districts.

Data from other networks:

+155 stations from OSS

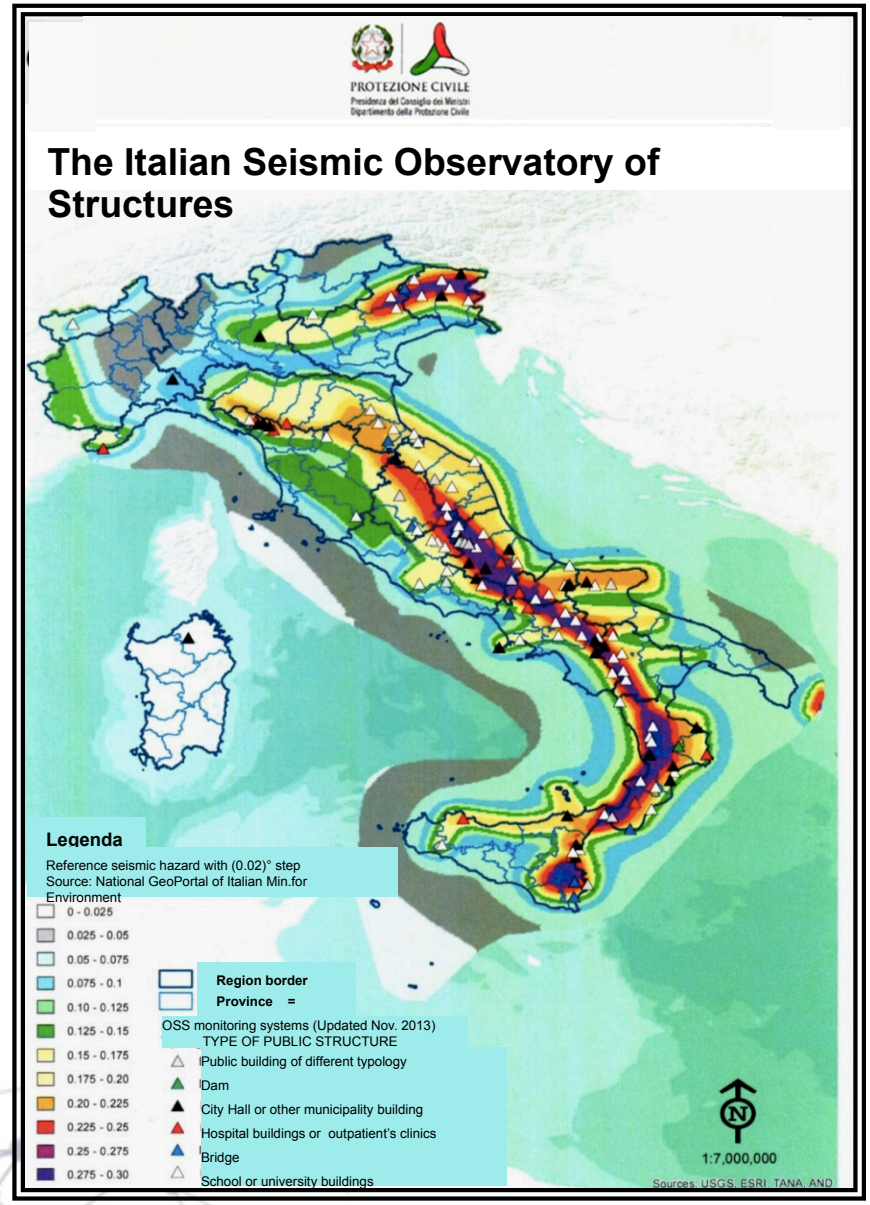
+140 stations from INGV

+ 3 stations from ARPAV

Upgrade of old RAN stations:

Since 2014, a gradual replacement is in progress of 281 old 18-bit triggered instruments, by means of new 24-bit high memory instruments, with continuous recording.

Strong Motion recording on structures: the OSS



With **98% efficiency**, the **Seismic Observatory of Structures (OSS)** records the dynamic response of **155 public structures** (147 buildings, 7 bridges and 1 dam):

schools 45%;
hospitals 18%;
town halls 20%;
other 17%,

with *reinforced concrete (65%)* or *masonry (35%)* structure.

Structures are chosen, that are **representative** of the public building stock and useful for **emergency management**.

OSS structure survey&modeling

DPC vibrodyne

Dynamic shaking test by impact of r.c. cube

Technical info collection

Geometry survey

Mech. properties survey *(r.c. coring, ultrasonic & flat jacks tests)*

F.E. preliminary model

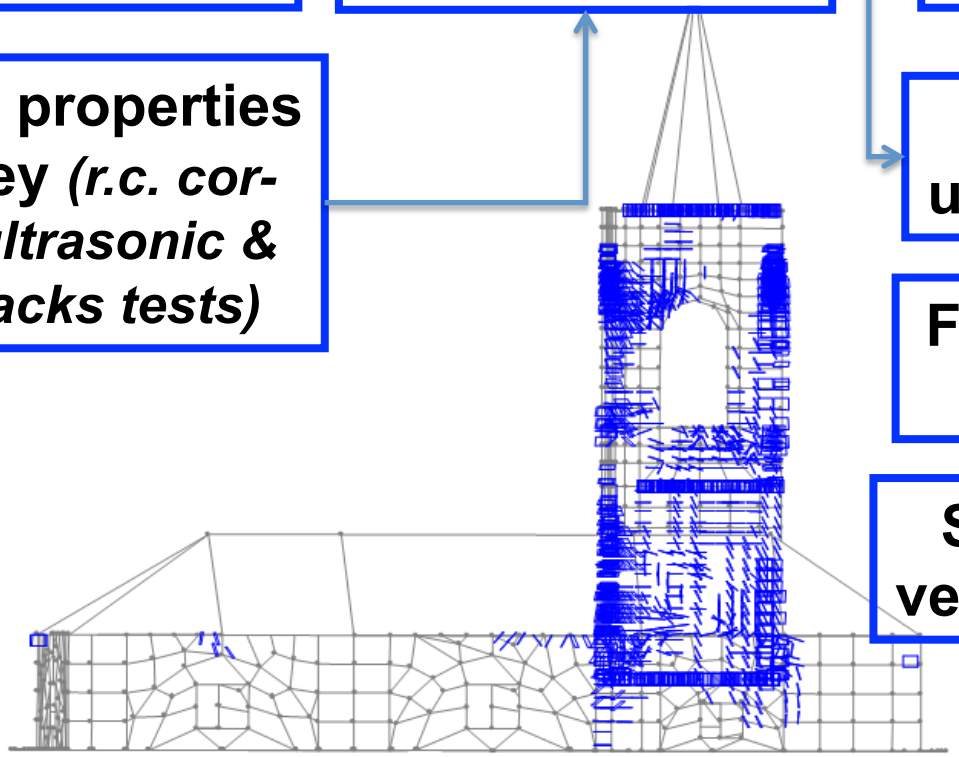
Ambient&forced vibration tests

Modal anaysis

Model updating

Final F.E. model

Seismic verification

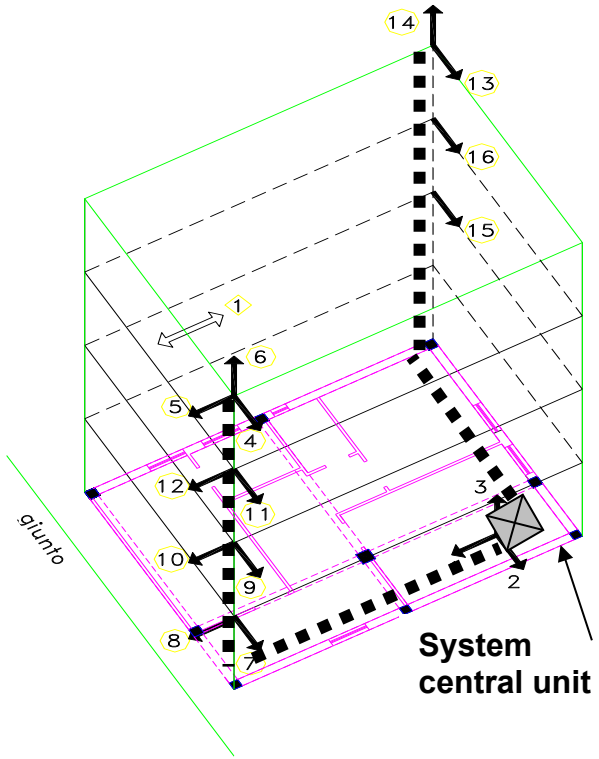


Numerical analysis of St.Catherine church at Fivizzano (Tuscany)

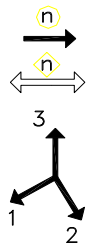
OSS monitoring systems

Structures are monitored in order to assess both their health state and possible earthquake damage.

Every floor (buildings) or span (bridges) or section (dam) is monitored with 4÷6 accelerometers, cable- connected with a central unit that converts to digital and records &transmits by ADSL triggered data to the OSS server in Rome, where data are processed, maxima and a damage index are computed, and (20' after the quake) data&results are shared through e-mail reports and a dedicated website.



Castelnuovo Garfagnana hospital



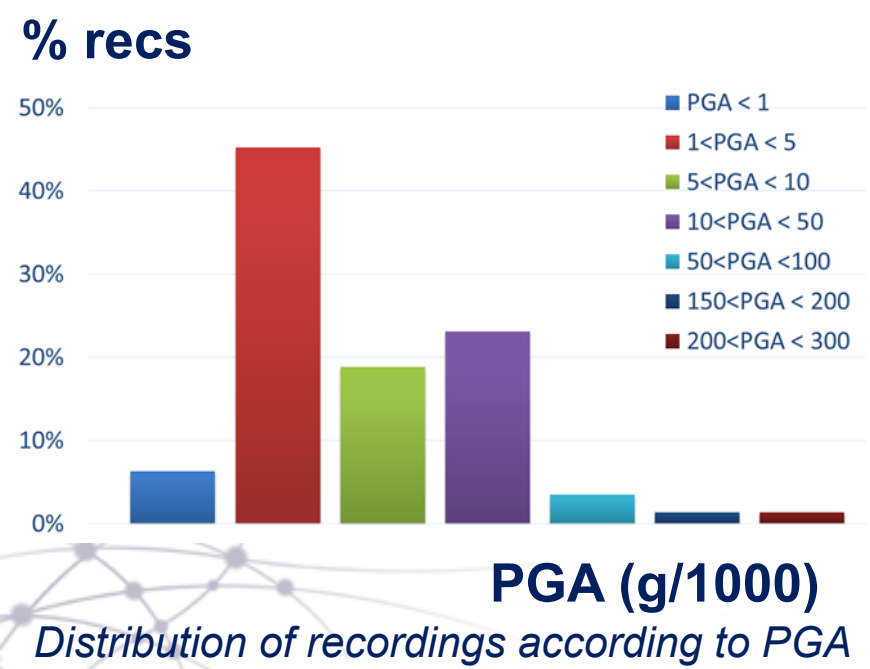
Force-balance accelerometer

Displacement sensor

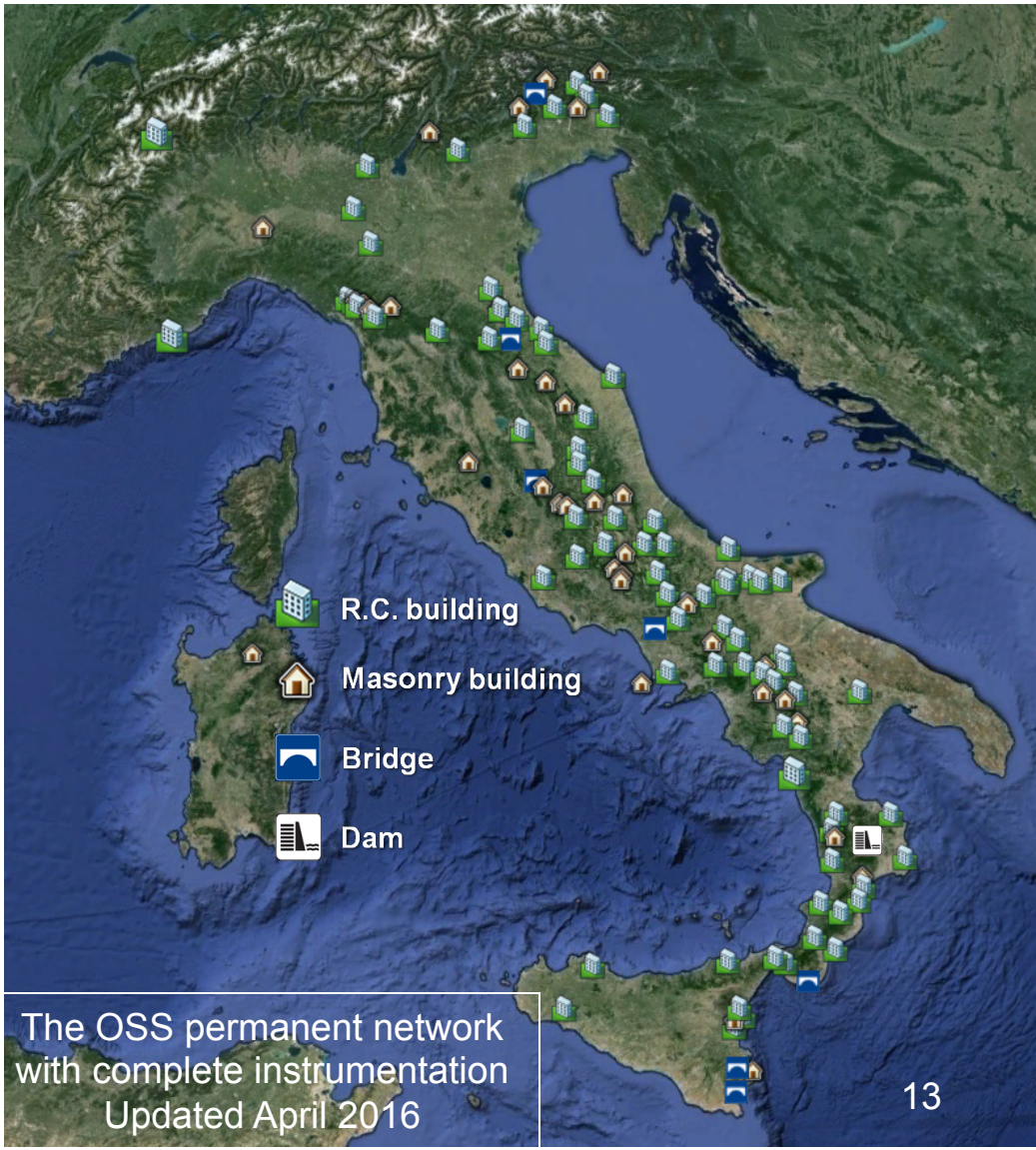
Triaxial f.-b. accelerometer

OSS archive

So far, OSS archive includes 1.551 structure recordings from 492 seisms. It is online and provides access to any available structure info as well.



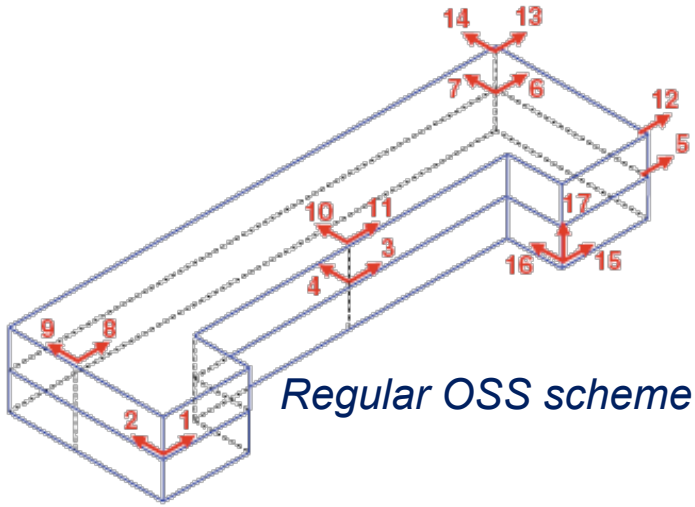
Distribution of recordings according to PGA



The OSS permanent network with complete instrumentation Updated April 2016

Further OSS developments

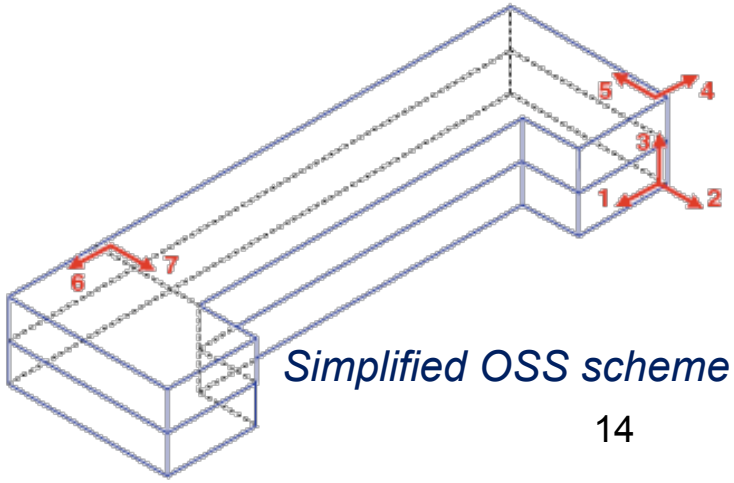
In 2016, 1 simplified and 2÷3 complete new OSS systems are scheduled. Moreover, an important upgrade of the 15 oldest OSS system central units is in progress.



Regular OSS scheme

25 simplified OSS systems for aftershocks became permanent. They monitor just top and ground level and account just for *global* damage, but, adding dynamic tests and modelling, could allow for a low cost OSS wide extension. Public&private partners are being sought who wish to contribute to such project.

City hall at Pizzoli



Simplified OSS scheme

DPC Seismic Monitoring Section

RAN (name, studies (main activities)

- **Luisa FILIPPI**, physicist (Kinemetrics and CESI RAN, CAED, Antelope)
- **Sandro MARCUCCI**, physicist (Syscom RAN, ISNet)
- **Rita DE NARDIS**, physicist (on leave)
- **Antonella GORINI**, geologist (Syscom RAN, ENEL, ISNet)
- **Elisa ZAMBONELLI**, geologist (Kinemetrics RAN, Antelope)
- **Franco PALMA**, technician (Syscom R.)
- **Riccardo BIANCONI**, technician (Kinemetrics and CESI RAN)

IT Consultancy

- **Alfredo AMMIRATI, Sebastiano SIRIGNANO, Alessandro LANCIOTTI**, IT experts (CAED, SW for RAN&OSS, TLC, web)

GPS – GEODESY

- **Roberta GIULIANI**, geologist
- **Maurizio MATTONE**, technician

- **Mario NICOLETTI,** engineer (Sect.head)
- **Stefania PASSA,** admin. (support)

OSS (name, studies (main activities)

- **Daniele SPINA**, engineer (GeoSIG OSS, CAED, dynamic response analysis)
- **C. Adriano DE SORTIS**, engineer (Leane OSS, survey and num. models)
- **Biagio PREZIOSO** (co-oper. from DPC IT Service), engineer (connectivity and data transmission)
- **Sara MARCHESINI & Maria DE BONIS** (consultants) engineers (OSS data, results and controls, analysis, models)
- **Giuseppe FALZONE**, technician (GeoSIG OSS, mobile network)
- **Roberto GERARD,** technician (Leane OSS, CAD and documentation)
- **Marco MARCHIONI**, technician (Cesi OSS, CAED, HW&SW)