A new integrated SEISMIC and GPS mobile network

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Istituto Nazionale di Geofisica e Vulcanologia

European Geosciences Union General Assembly 2011
Vienna | Austria | 03-08 april 2011

INGV

INGV *(Istituto Nazionale di Geofisica e Vulcanologia)* is currently using different communication systems for the **acquisition of seismic and GPS data** from remote stations.
The heterogeneity of these connection systems provides strength and redundancy for national seismic monitoring.
Nowadays almost all seismic and gps stations use a remote IP connection for data transmission. A more simplified, mature and reliable access to this type of connection is now possible thanks to recent developments occurred in telecommunications. The implementation of an IP connection is possible using the existing similar telephone and networks (*ADSL*) system, through the creation of an ad-hoc networks for data exchange, as for **RUPA** (*Unified Network of Public Administration*) , or through links to recent satellite-using suppliers, as **Nanometrics**, **Astra2Connect** etc.

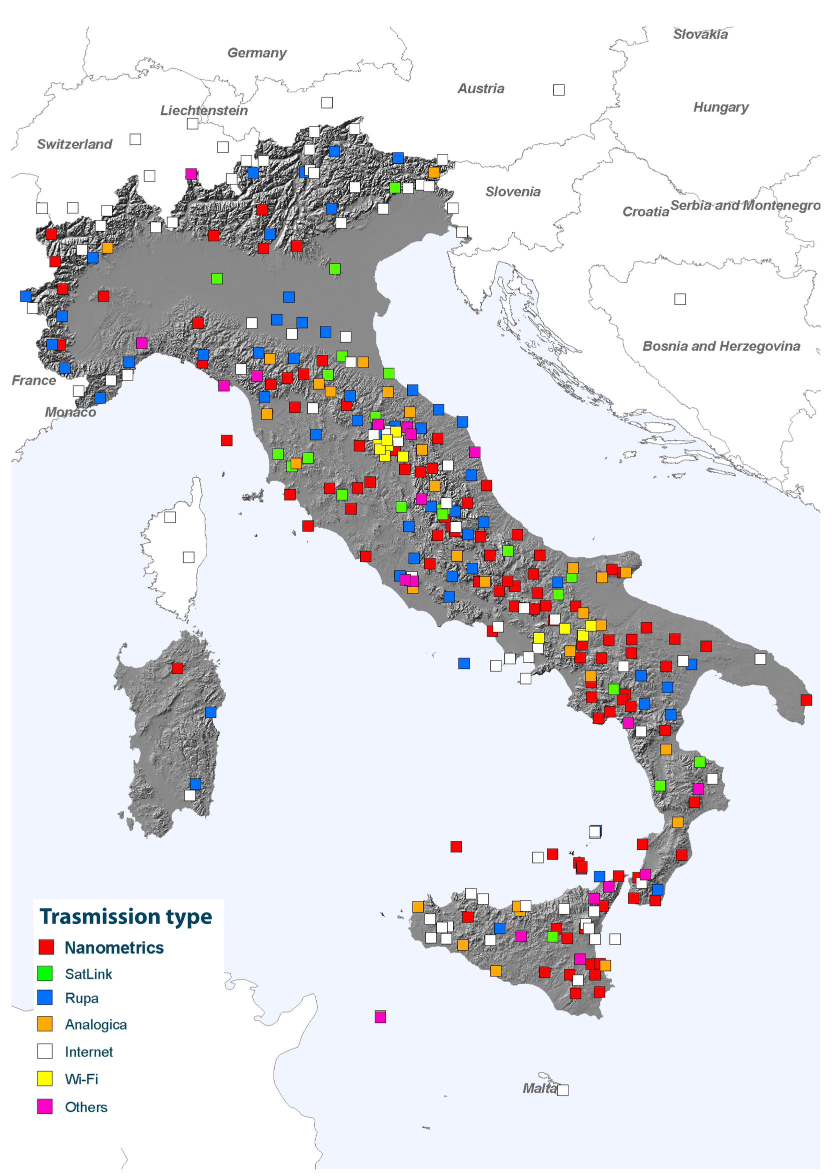

Fig.1: RSN map for trasmission type

The INGV-Sede Irpinia has implemented a new conception of seismic mobile network. It is based on the Wifi-data transmission and it is called **WI-FI MESH NETWORK (W.M.N.).**
The Aim of this work is to realize a telemetered infrastructure for seismic and GPS data acquisition. This infrastructure is reliable, robust and it guarantees the minimum bandwidth useful for future applications requiring high troughput with high sampling rates (as for strong motion and GPS instruments). Thus the WMN is perfectly integrated into the different data trasmission systems used at INGV.
INGV decided to internally develop such an advanced network in order to have a full control on the whole infrastructure (installation and configuration of the radio devices for the GPS and seismic data acquisition).
The MESH technology does not represent a novelty from technical point of view, but recently its applications are more and more distributed and frequent. The Mesh networks use the same technology as the Wi-fi, with some little differences. In the traditional system, based on hot-spot points, there is a tree-like architecture, and every access point must be connected to cabled internet network. This approach can be too complex and expensive if wide areas have to be reached and covered.

The Mesh networks have a **mesh-like architecture**, and it works as Internet: the access points are able to dialogue among them and everyone has routing functionalities. This means that every access point is able to redirect data packets to another knot of the network. Only one access point is needed to be connected to the cabled network. Further physically connected access points can be added to increase the global reliability of the system.
The developed network project is the following: **every knot of the network (STxx) represents a remote router** and it is equipped with one or more radio devices to obtain the connection to the adjacent sites and a robust redundancy of the radio links.

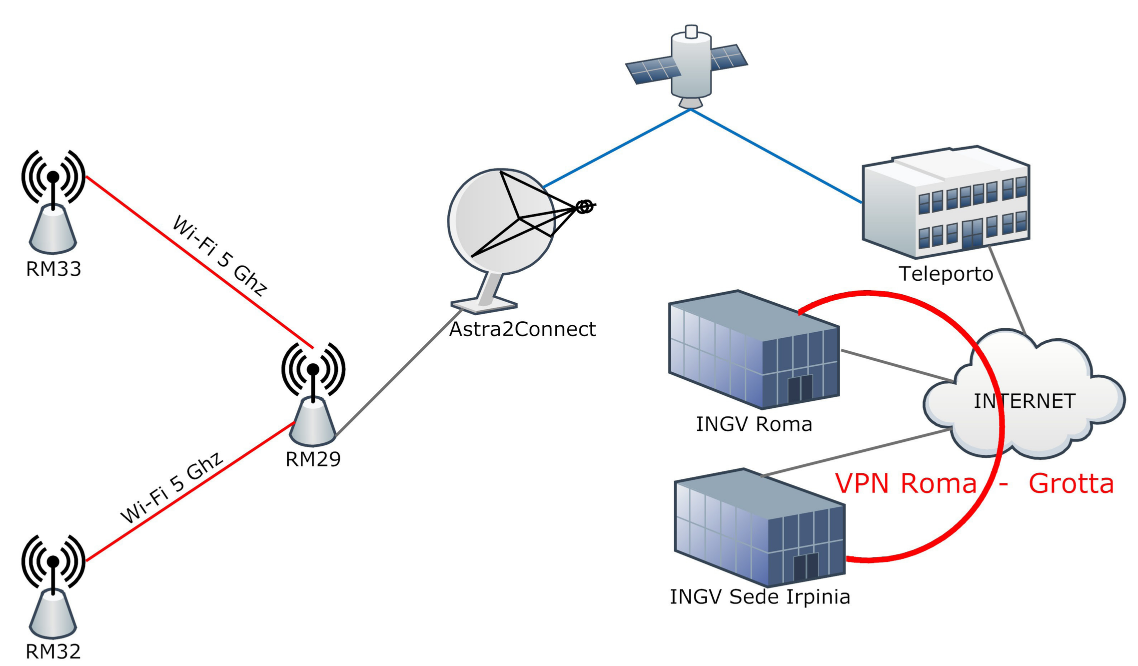

Fig.2: Wi-Fi network layout

HARDWARE

The devices used for the creation of the mesh network are **Mikrotik products** (*www.mikrotik.com*). Mikrotik is a producer of wireless routers (*RouterBOARD*), managed by the software (*RouterOS*), based on Linux operating system, which allow the user to transform a conventional PC in an advanced router with different functions (firewall, VPN server and/or client, bandwidth shaper, wireless access point, etc.).
The routers used in our networks are mainly **RouterBOARD 433, RouterBOARD433AH, RouterBOARD 600, and RouterBOARD 450G.**

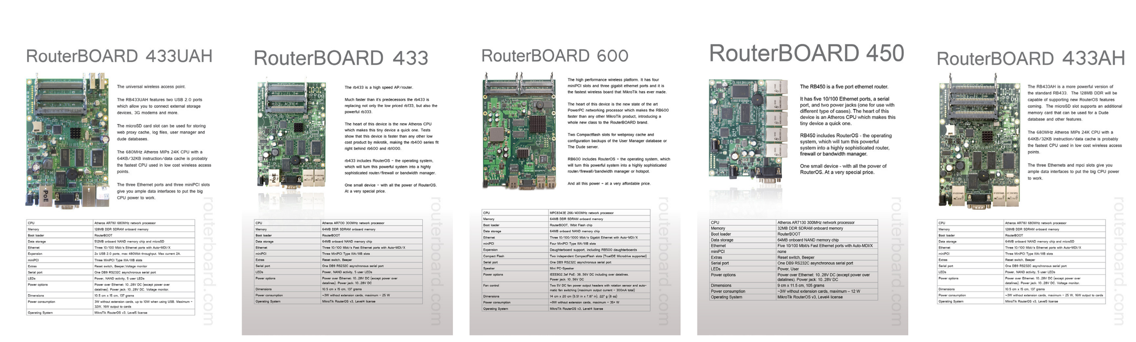

Fig.3: Motherboard Datasheet

RADIO

The radio devices used in the mesh network are: Ubiquiti Super Range 5, Ubiquiti UB-5 and Compex WLM54AG (fig.4). The choices of the radio types have been done in function of the distance to be covered, the antenna type and its relative cable.

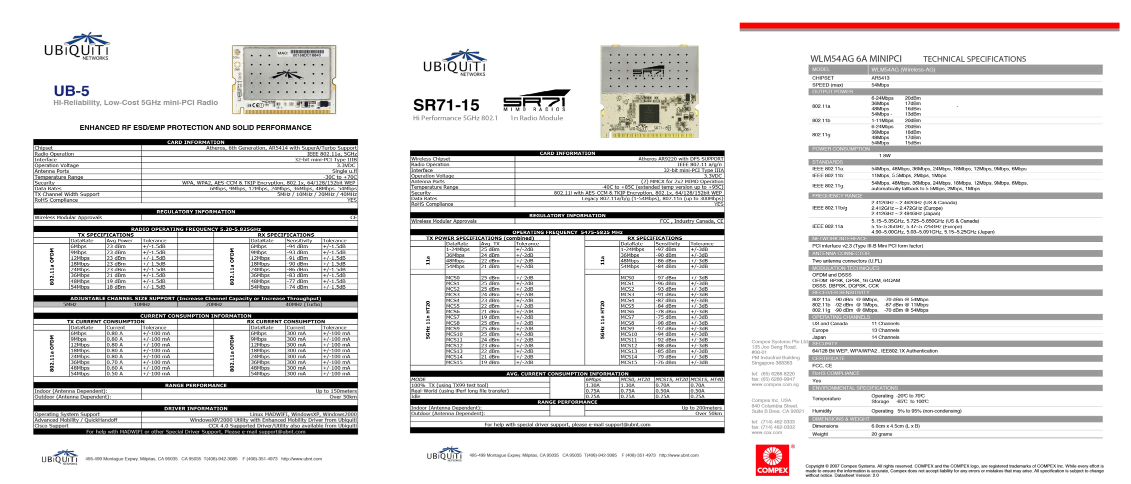

Fig.4: Radio Datasheet

ANTENNA

The antenna types changed in function of the distance to be covered.: antenne patch with 23 dbi (fig. 5). The technical aspects of antenna type are the following:

Frequency Range	5150-5850 MHz
Gain	23 dBi
Horizontal Beamwidth	10 °
Vertical Beamwidth	10 °
Mounting	Diameter 30-50 mm
VSWR	1 to 1,4
Impedance	50 ohm
Polarization	Horizontal or vertical
Output connector	NFemale type
Weight	1,8 kg
Overall dimensions (W x L)	390 x 430 mm

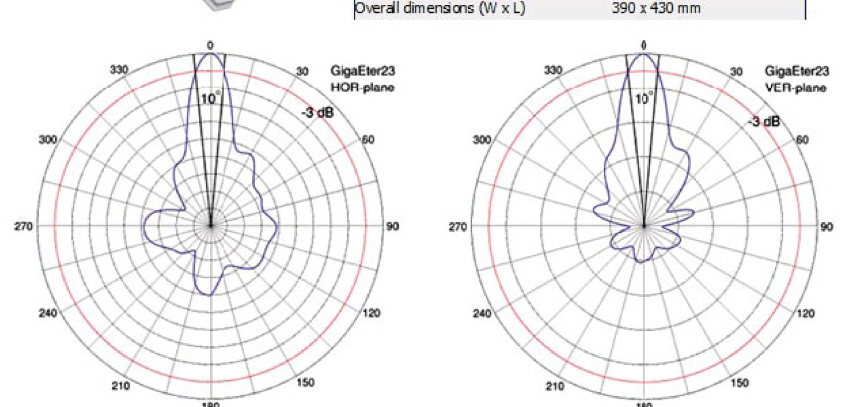

Fig.5: Antenna's Datasheet

TEST SITE: " MONTEREALE, AQUILA-ITALY"

Introduction
Starting from September 2010, a seismic sequence occurred in the Montereale region (Fig. 6). Thus, we decided to install a-temporary network with the aim to densify the INGV real-time seismic network in the seismic sequence area.

Increasing the numbers of seismic stations in the area, we wanted to lower the magnitude threshold detection of the INGV seismic network. The Montereale seismic sequence represented the opportunity to test the new INGV Wifi Mesh Network.

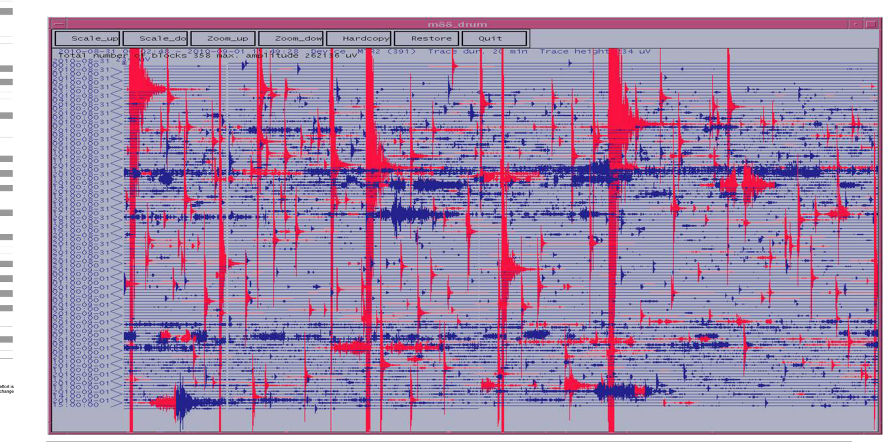

Fig.6: Earthquakes recorded in the Montereale area in September 2010

Implementation
We installed three sites which were previously occupied by the stand-alone seismic stations that have recorded the L'Aquila aftershock distribution. The sites were named RM 10 (poi divenuta 33), RM 29, RM 32 (Fig 7).

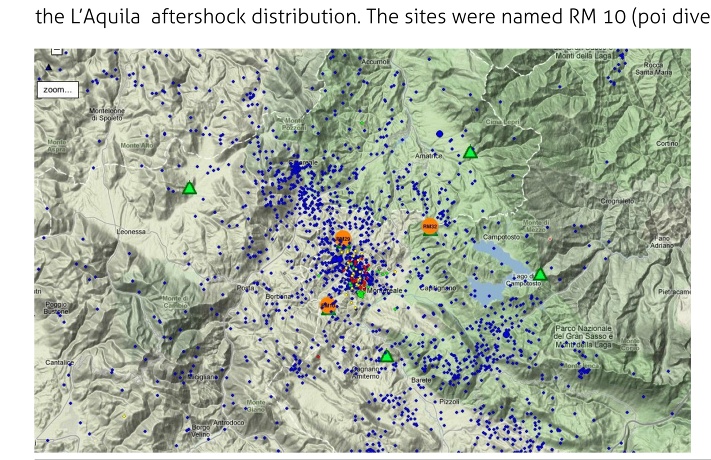

Fig. 7: Orange circles represent the WMN sites

One of the critical issues was the need to adapted this network to the real conditions of the field (not optical visibility between the sites). Thus, we firstly built up an opportunely shaped pole to install solar panels, a 42 Ah battery, a charge regulator and the Gaia2 digitizer.

Fig. 8: An example of seismic station

Presently, the sites are the following:

Stazione 29, seismic data acquisition with the devices Lennartz 5 s with 100 Hz sampling rate and Episensor with 200 Hz sampling rate;

Stazione 32, seismic data acquisition with the devices Lennartz 5 s with 100 Hz sampling rate;

Stazione 33, seismic data acquisition with the devices Lennartz 5 s with 100 Hz sampling rate; an Episensor with 200 Hz sampling rate and a GPS Leica GRX 1200+ GNSS with sampling rate.

To assess the effects by the introduction of W.M.N. stations in the existing network (located to Monti della Laga), we have plotted the threshold of Magnitude in Time.
The reporting period is from 01/01/2009 to 16/03/2011.
It is noted that with the arrival of new stations, which occurred in September 2010, the minimum threshold of detection of network goes down to magnitude near zero (Fig. 9 - Fig. 10 - Fig. 11).

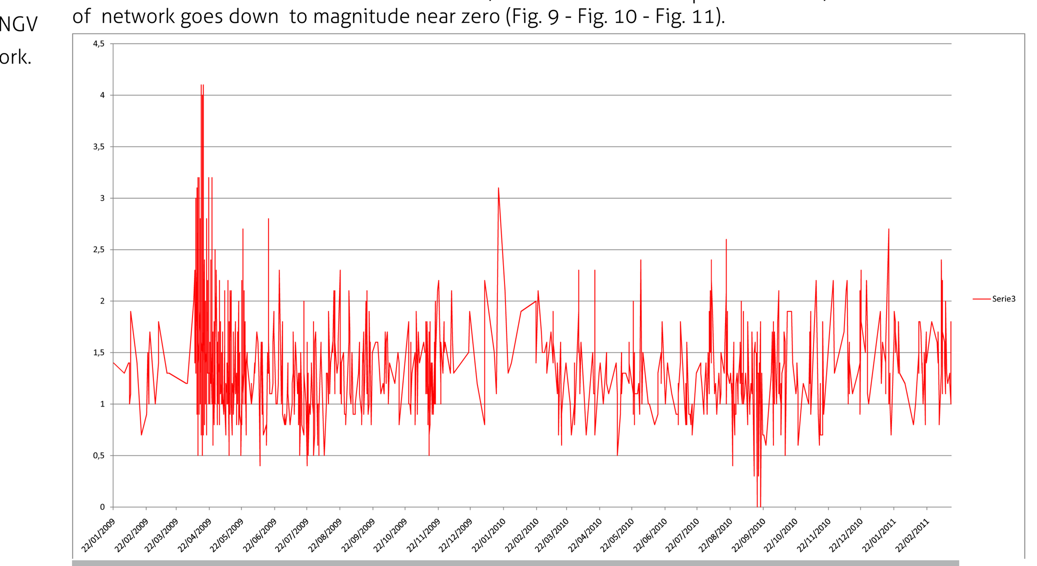

Fig.9: Show Minimum threshold dection of network before and after installation in September 2010

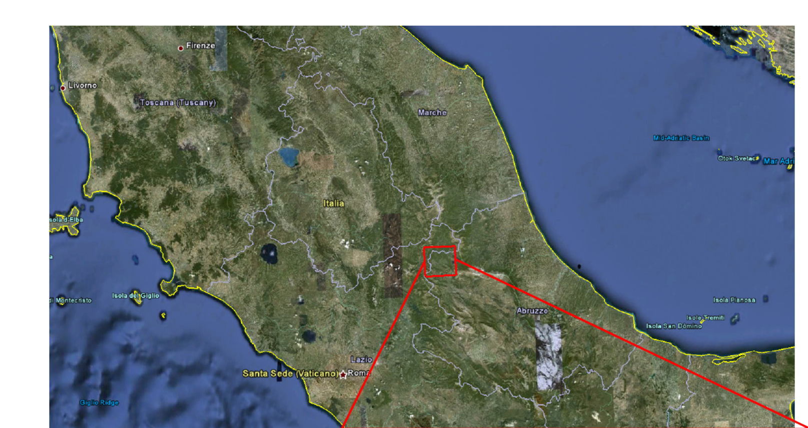

Fig.10: Area of seismic sequence

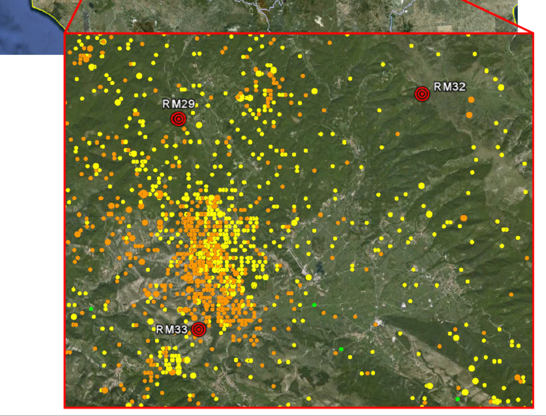

Fig.11: Dislocation of seismic station

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