

G-Sense

A Low Cost Real-Time Building Earthquake Damage Assessment System

Dimitris Diagourtas, Lefteris Voumvourakis, Leonidas Perlepes and Antonis Kostarids
Satways Ltd, 3 Ch. Lada, 15233, Halandri, Greece Tel: +30 210-6840036, email: d.diagourtas@satways.net

Abstract

In the frame of a Nationally funded research project, Satways Ltd. developed the G-Sense system, a low cost building rapid damage assessment system, comprising of a network of sensor nodes installed in different floors of a building measuring continuously building motion and more specifically, acceleration. The nodes include a low noise MEMS tri-axial accelerometer, a 16bit ADC, a power control (UPS) unit, an integrated processing unit enabling on-board processing, GPS for time synchronization and a gateway (mini PC) for real-time data acquisition, analysis and archiving. The gateway is calculating damage probabilities for every floor following an earthquake event based on the continuous calculation of inter-story drift ratio for every pair of sensors installed in consecutive floors and considering the fragility curve of every specific building. The damage probabilities are formulated as damage alerts and are sent to a central command and control software that monitors all G-sense installations in different buildings and visualize in a GIS system all received damage alerts. The central command and control software monitors also the nodes state of health and enables the change of the nodes and gateway configuration remotely when required. After extensive lab tests, the G-sense system was installed initially in several buildings for field testing in real conditions.

The low cost sensor node

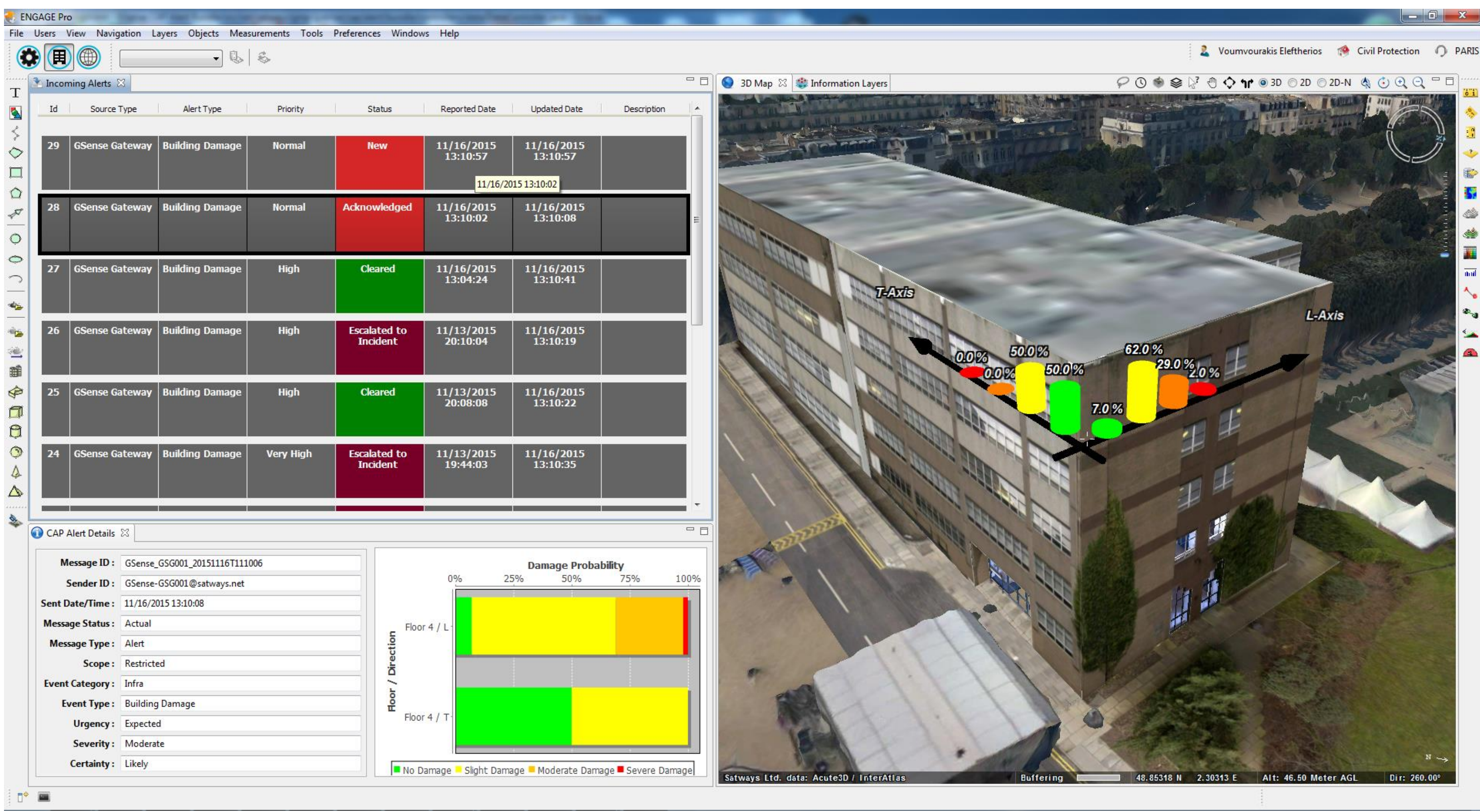
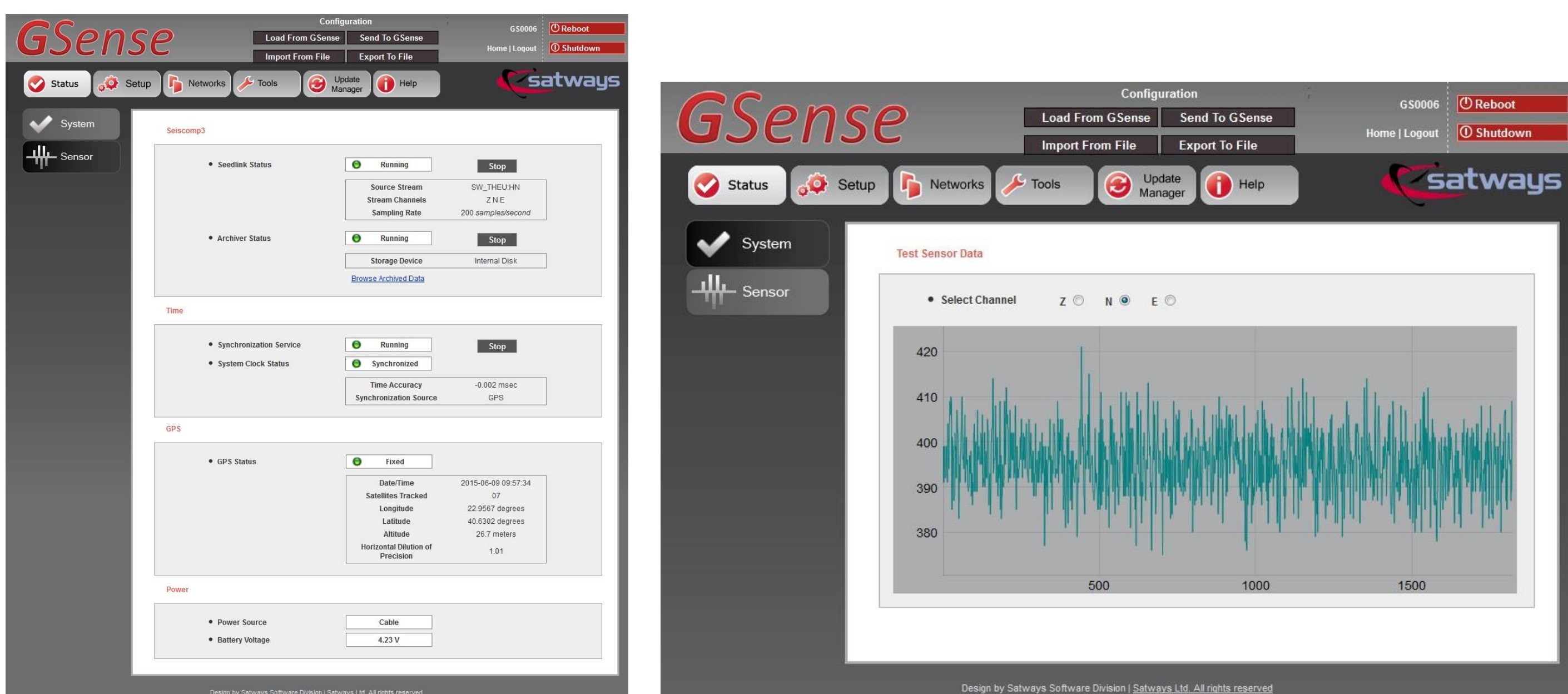


Node Specifications	
Power	
Input Voltage	5 VDC
Operating Power Consumption	~3W
Internal UPS with 2500mAh LiPo battery (Up to 5 hours Autonomy, Automatic battery charger)	
Powering options	Ext. AC adapter Ext. battery or solar panel
Internal Accelerometer	
Acceleration Measurement Range	± 2 g
Acceleration Measurement Resolution	76.3 µg
Frequency Range	DC to 497 Hz
White Noise σ	300 µg
Noise Density	45 µg / √Hz
Minimum Drift σ	37 µg
Sensitivity	660 mV/g
ADC Board	
Analog to Digital Converter Resolution	16 bit
Current Consumption Max	35 mA
Sampling Rate	1 Hz to 1000 Hz
Dynamic range	93.8 dB
Time Base	
Type	GPS with ext. Antenna
Time accuracy (GPS locked)	~100µsec
NTP synchronization	
Integrated Processing Unit	
Operating System	Linux
RAM	512Mb
Storage (microSD)	32Gb
Communications	Ethernet, wifi, usb
Recording modes	Cont., Event (STA/LTA), Level
Data Format (seedlink server installed)	mSEED
Enclosure	
Environmental protection	IP65

Central Command and Control Software

- Receive and Decode Alarms
- Visualize Damages
- Remote Control of G-sense nodes

G-sense web interface



Pilot Installations and initial recordings

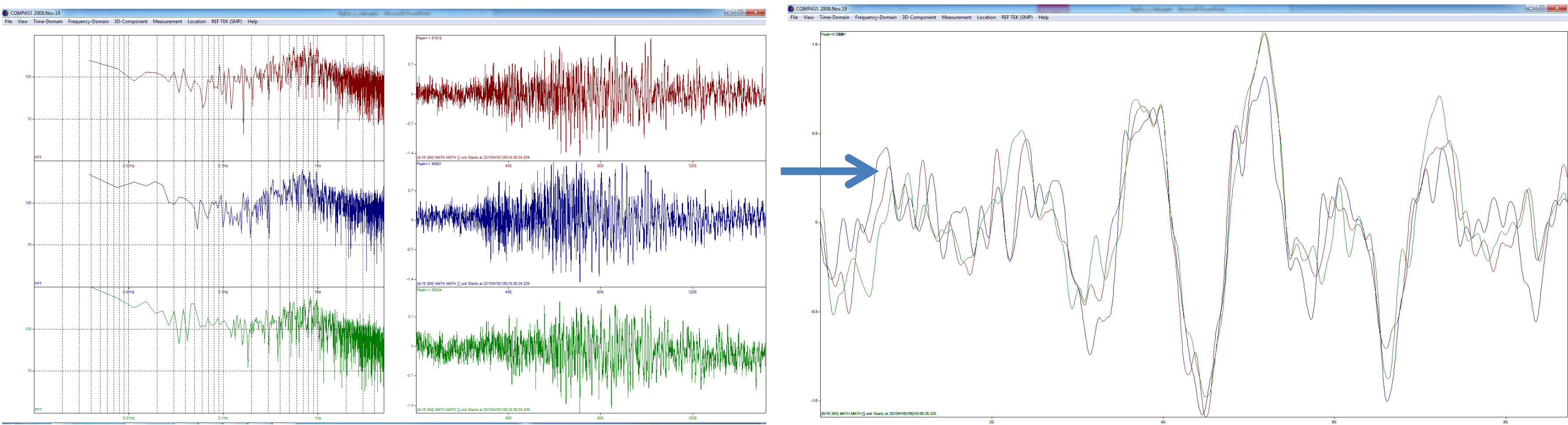


Technological Institute of Crete
G-Sense installed close to REFTEK accelerographs



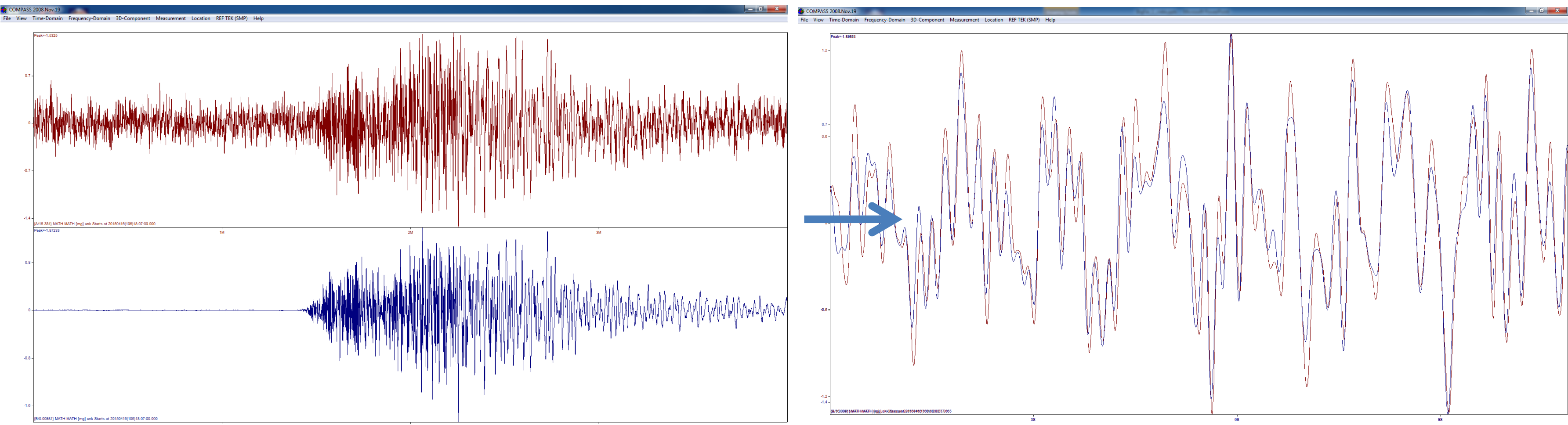
University of Thessaloniki,
Administration Building

Recordings of the M=6.1 of 16/4/2015 earthquake at 150 km away



G-sense Recordings, E-W, Red: 1st floor, Bleu: 3rd floor & Green: Underground

Superposed recordings from every floor and zoom



Comparison G-sense/REFTEK Recordings, E-W,
Red: G-Sense - Blue: Reftek

Superposed recordings and zoom