WI-GIM Life: Wireless Sensor Network for Ground Instability Monitoring

The technology

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Assistant Project Manager

WORKSHOP

Monitorització del terreny com a eina de gestió del risc i presentació del Projecte Europeu Wi-GIM

Institut Cartogràfic i Geològic de Catalunya

Barcelona, 27 January 2017

WI-GIM Life Project (LIFE12/ENV/IT001033)

- Wireless Sensor Network for Ground Instability Monitoring

  Beginning date: 01/01/2014

  End date: 31/03/2017

  Total Budget of the project: € 1.043.090 (EU Contribution 49%)

- Coordinating Beneficiary:

  International Consortium on Advanced Design (ICAD) - Italy

- Associated Beneficiary:

  - Earth Science Department – University of Florence (DST) - Italy
  - Institut Cartografic i Geològic de Catalunya (ICGC) - Spain
  - Istituto Nazionale di Geofisica e Vulcanologia – Sez. Pisa (INGV) - Italy
  - Regione Emilia-Romagna (RER) - Italy

Landslide monitoring technology

SURFACE CONTACT TECHNOLOGY

Extensometer
Inclinometer

Disadvantage: INSTALLATION

REMOTE SENSING TECHNOLOGY

SAR Systems

Disadvantage: COSTS INSTALLATION

WSN

Wireless Sensor Network

- Cost effective node
- Easy and quick installation
- Good Accuracy (it depends from technology)

WI-GIM Life major technology Innovation

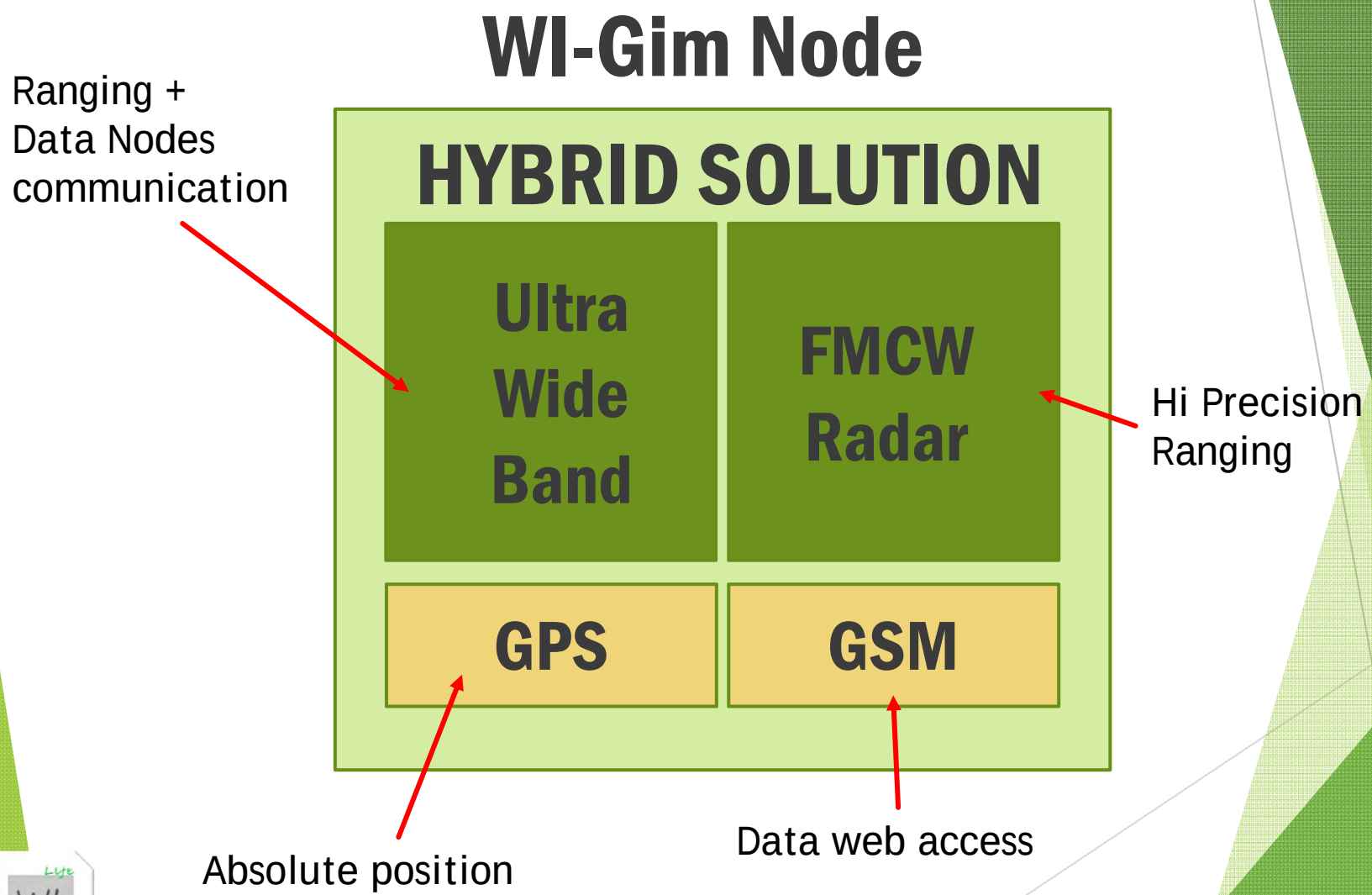
WSN + RANGING RADIO

Wireless Sensor Network benefits

+

Sensor node distance measurement with radio frequency technology

WI-GIM Life: Ranging technology



Ultra Wide Band

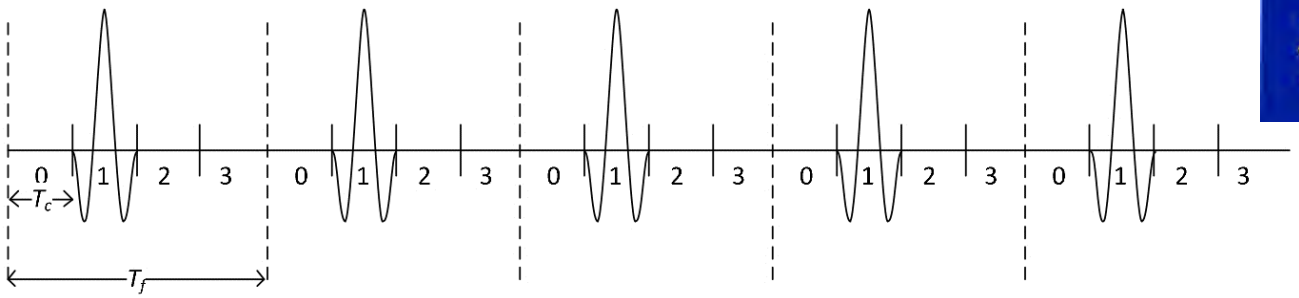
LAB TEST RESULTS

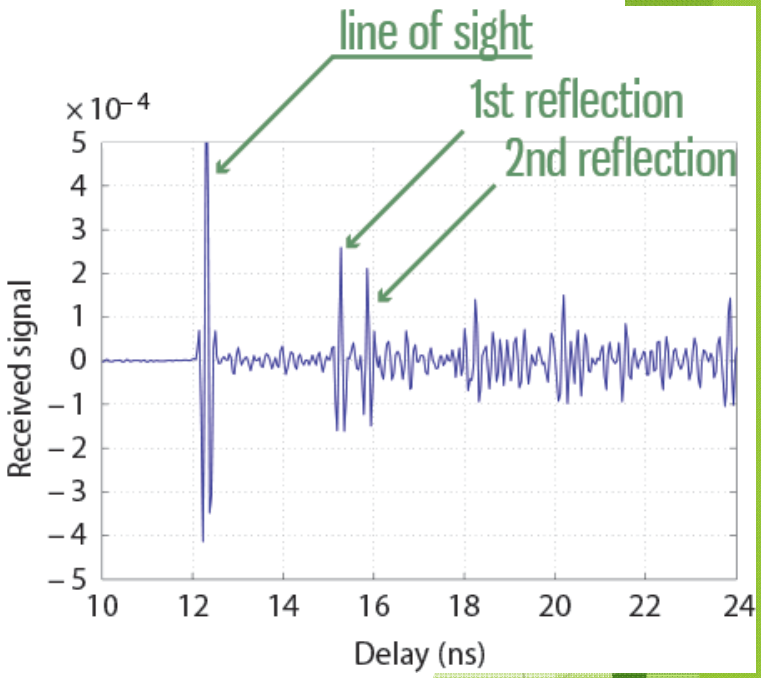
Accuracy: ±8 cm

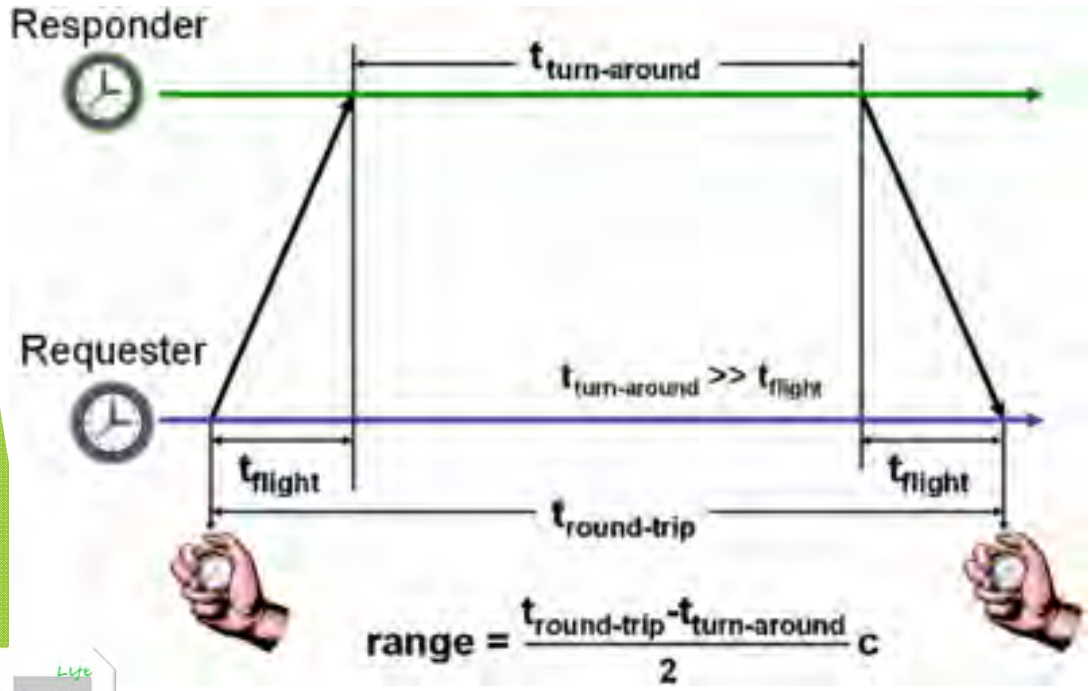
Coverage: 150 m (LOS)

Ranging + Communication

Ultra Wide Band







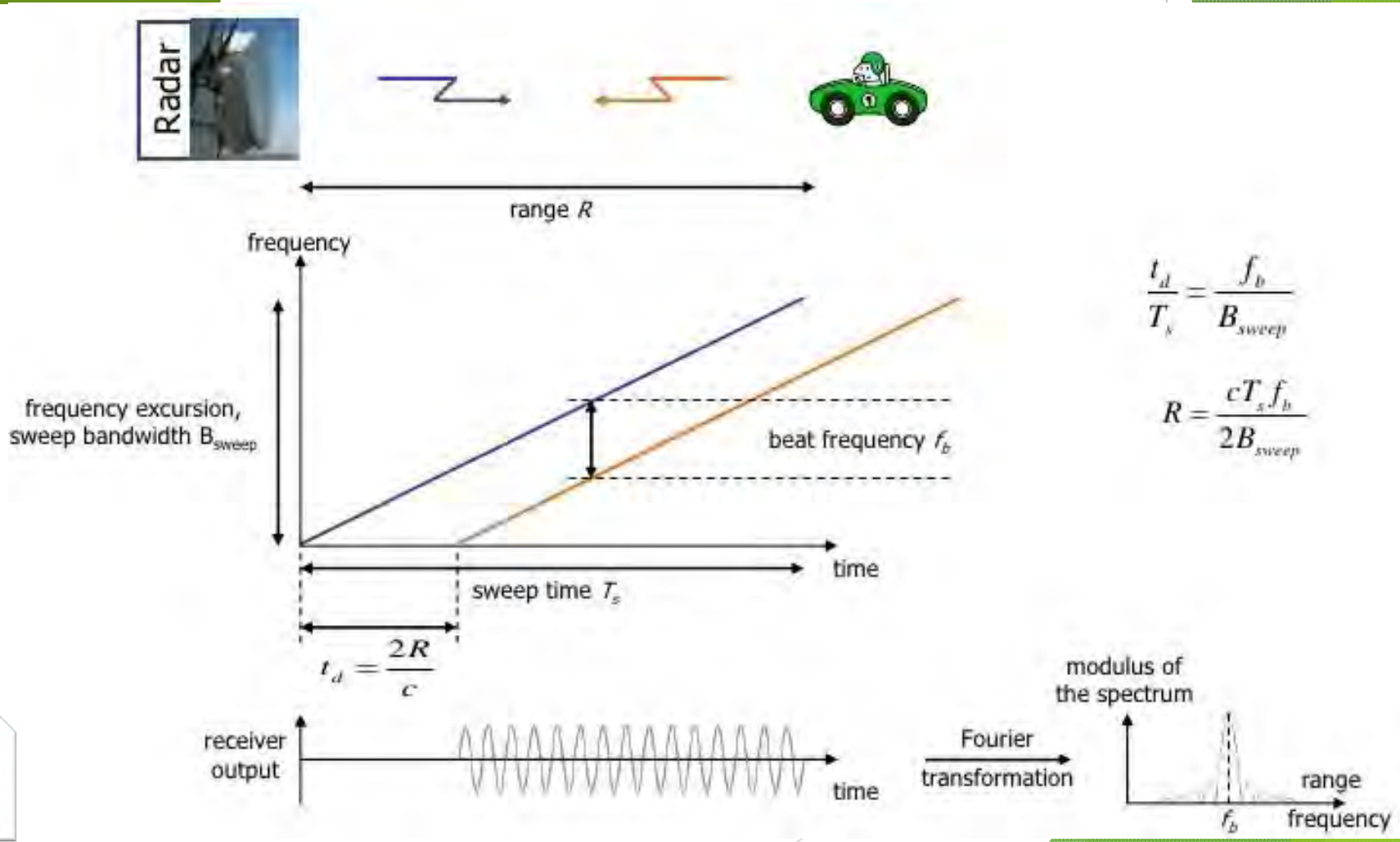
FMCW Radar

LAB TEST RESULTS

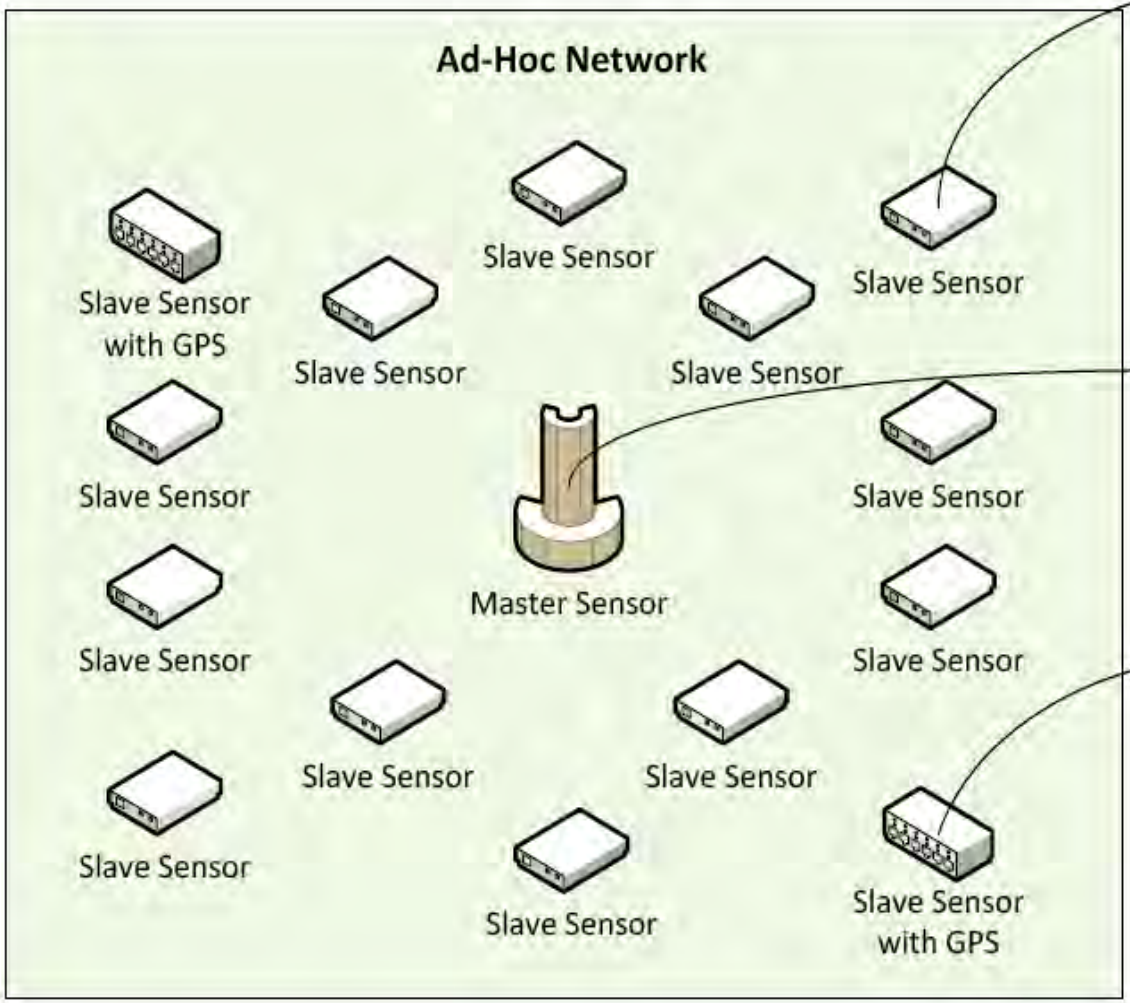
Accuracy: ≈ 8 mm

Coverage: ≈ 70 m (LOS) It depends on the target surface area

FMCW Radar


Radar
range R
frequency
frequency excursion,
sweep bandwidth B_{sweep}
beat frequency f_b
time
sweep time T_s
$t_d = \frac{2R}{c}$
receiver
output
time
Fourier
transformation
modulus of
the spectrum
range
frequency
f_b
$\frac{t_d}{T_s} = \frac{f_b}{B_{sweep}}$
$R = \frac{cT_s f_b}{2B_{sweep}}$

WI-GIM Life: General architecture



Slave Sensor with UWB module

Master Sensor with UWB/Radar module, GPS module and SD Card

Slave Sensor with UWB module and GPS module

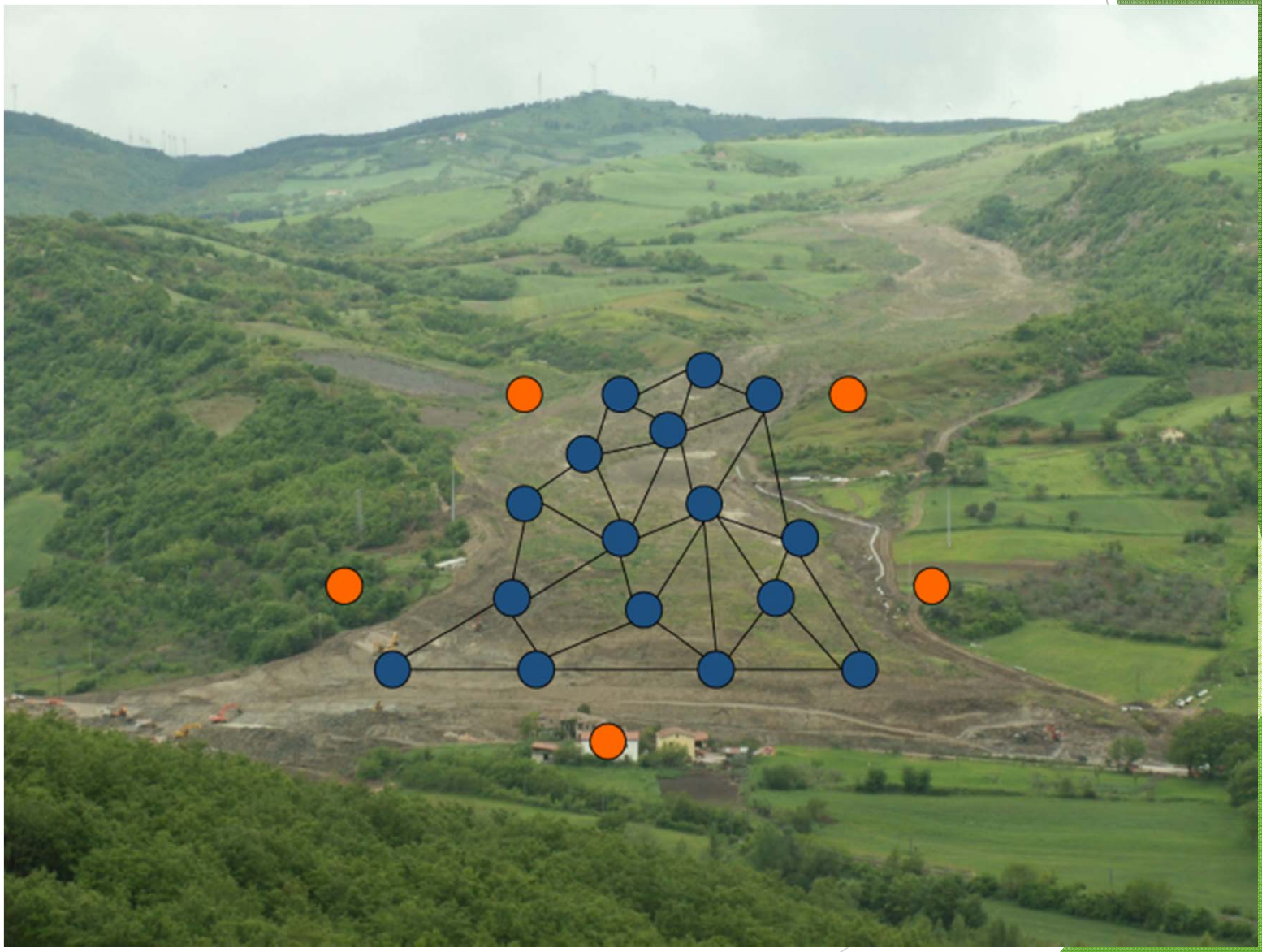
WI-GIM Life: Benefits of ad hoc networks

The architecture has been designed as an ad-hoc sensors network

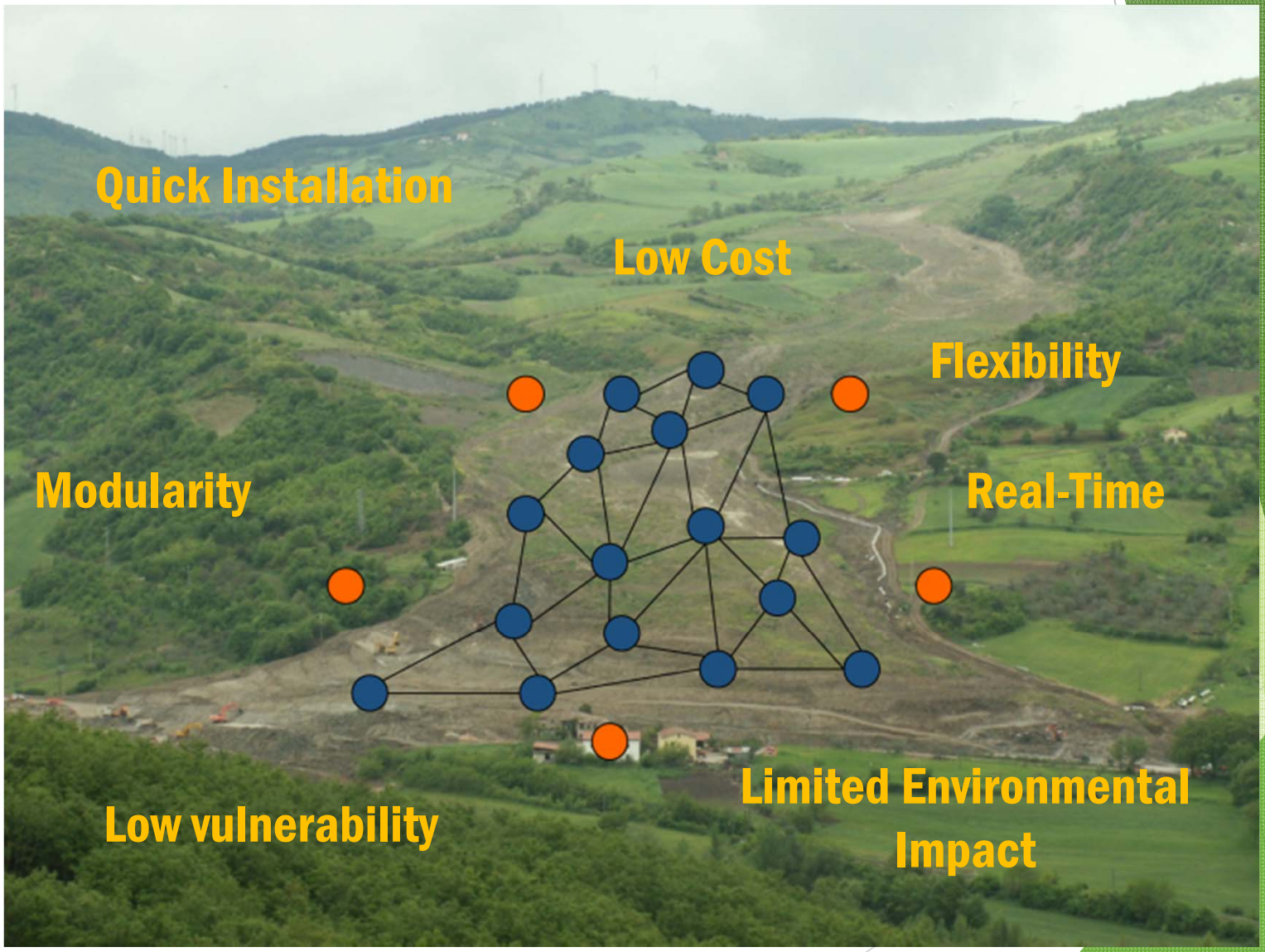
- **Cluster-based**
  - ✓ **Independent clusters**
  - ✓ **Non-contiguous areas can be monitored at the same time**
  - ✓ **More flexibility**
  - ✓ **More scalability**
  - ✓ **More adapt to future upgrades**

- **No need for a “stable” area**
- **User-friendly configuration wizard**
- **Remote alarms**
- **Remote periodical report**

WI-GIM Life: Project Idea

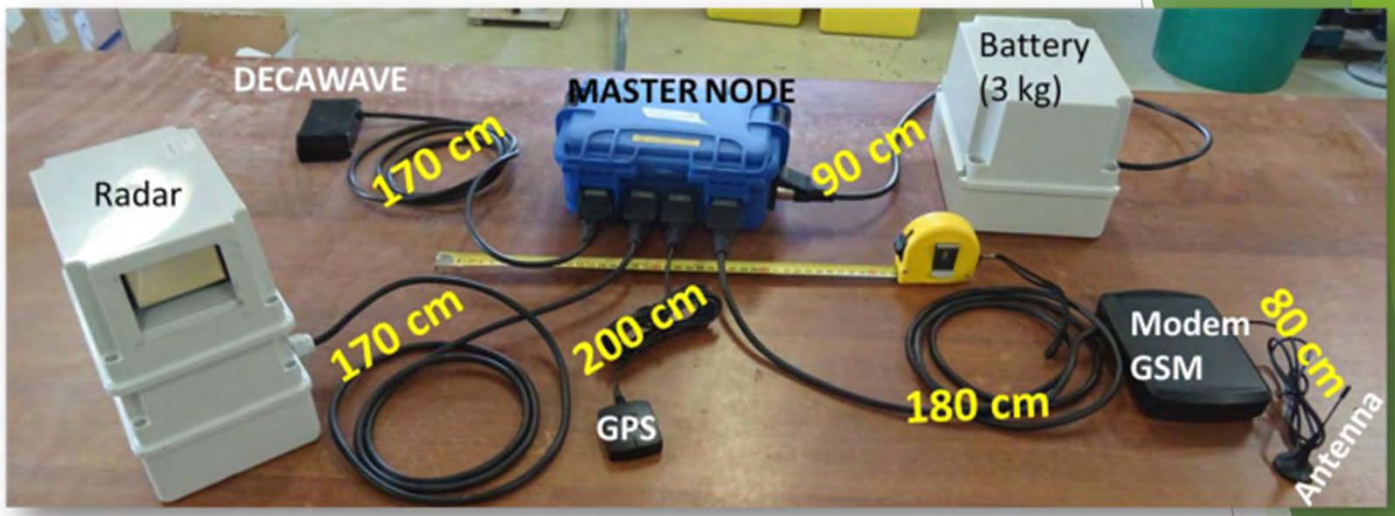


WI-GIM Life: Project Idea

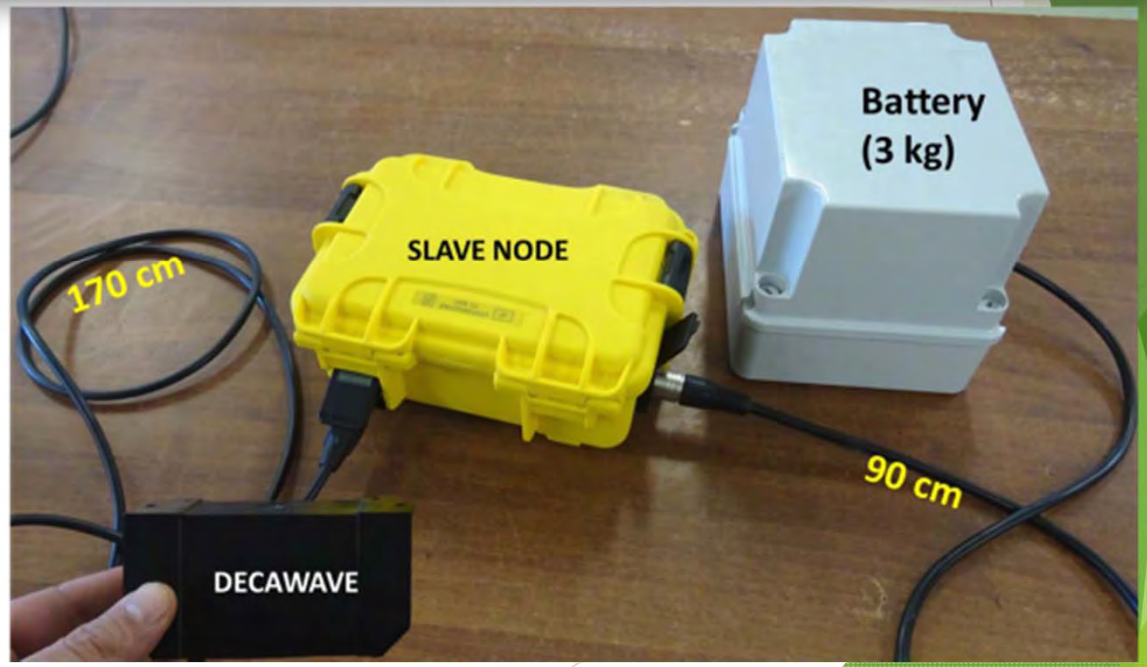


WI-GIM Life: Prototype Development

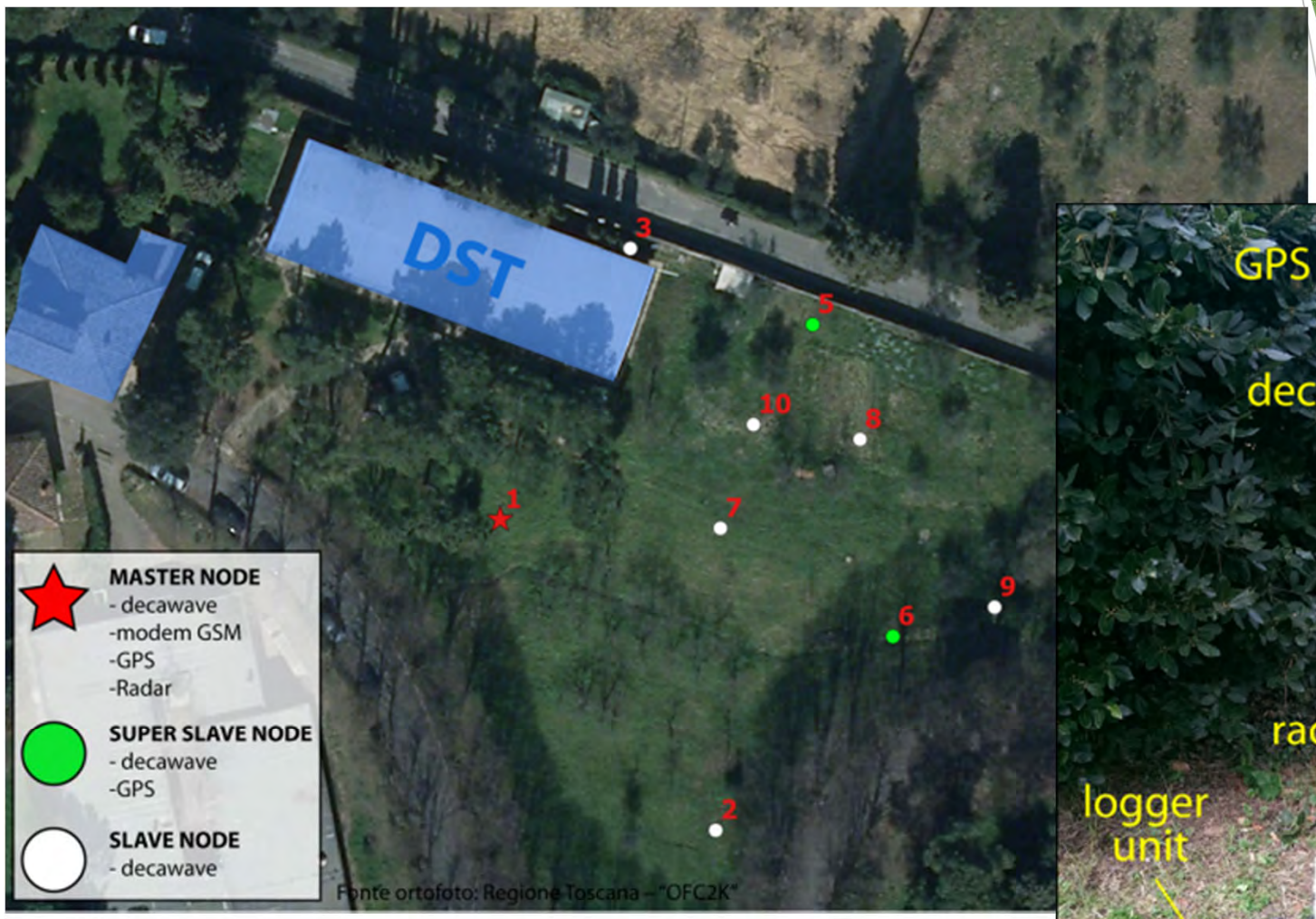
MASTER

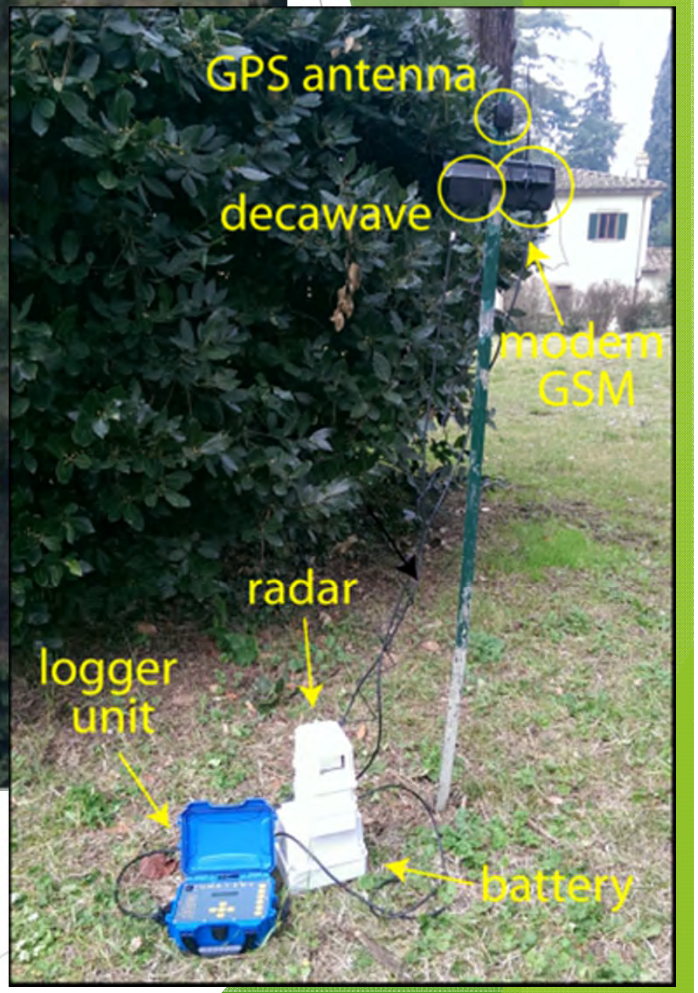


SLAVE

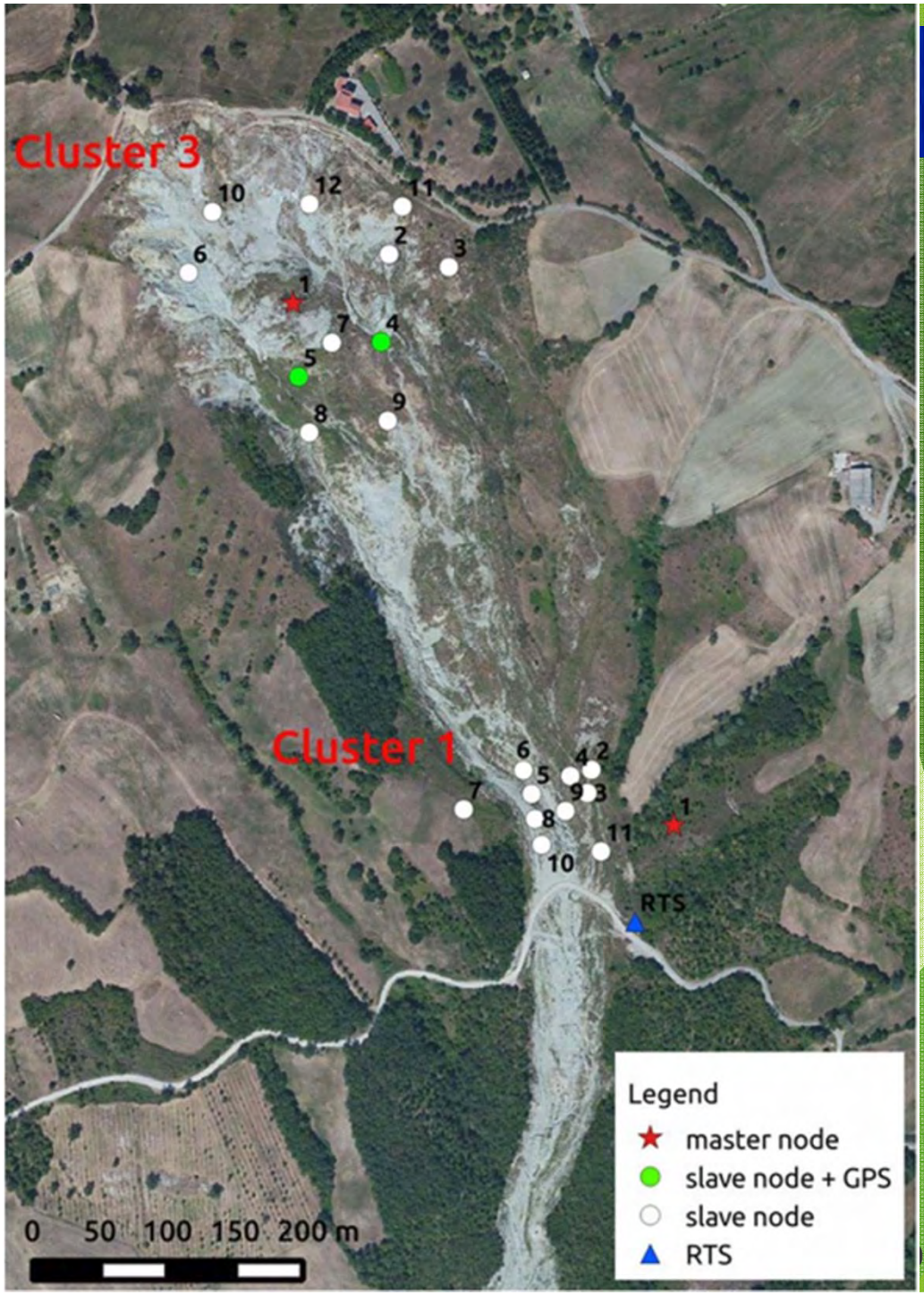


WI-GIM Life: Prototype Testing

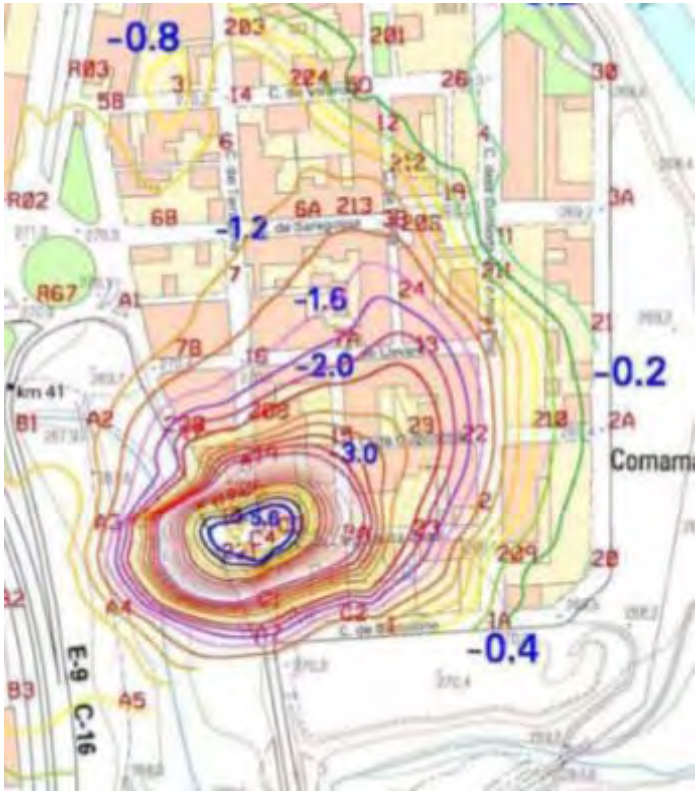




WI-GIM Life: Roncovetro Experimental Site



WI-GIM Life: Sallent Experimental Site



Master Node UWB

Master Node Radar

WI-GIM Life: Technology

System Offsets

- Compensation of Sensitivity of Decawave UWB algorithm

Outliers

- Algorithms for identification and compensation of outliers have been developed

Electronic noise depends on temperature

- It has been compensated with data post-elaboration

Compact and resistant chassis

- Atmospheric agent resistant (snow, rain, humidity)

System Power Consumption

- Event-driven wake-up firmware algorithms have been developed to perform energy saving on battery
- Solar Cell add-on available

WI-GIM Life: Technical Results

ACCURACY OF RAW-DATA HIGHER THAN EXPECTED

THE SYSTEM WORKED WELL IN EXPERIMENTAL SITE

- Early warning possible device for fast landslides (type 3-7)

WEB DATA POST-PROCESSING CAN FURTHER REDUCE THE ERRORS

HIGH POTENTIAL OF INDUSTRIALIZATION

- Device can be much smaller in the final version
- Energy consumption can be much less with further hardware and software optimization

THANK YOU
FOR
YOUR ATTENTION

http://www.life-wigim.eu

WI-GIM Life EU Project

WI-GIM Channel

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