



# GENESI: Green WSNs for long lasting structural health monitoring

*Catania, June 11<sup>th</sup> 2012*



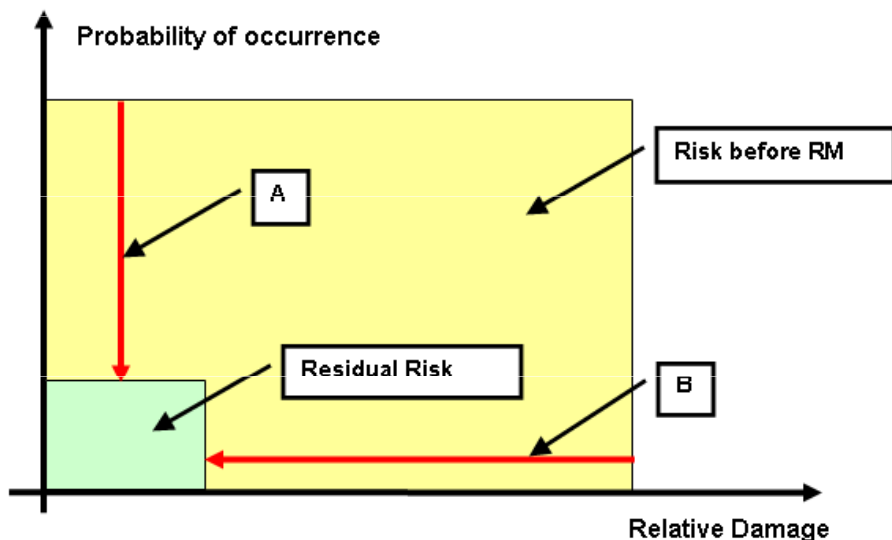
Coordinator: Prof. Chiara Petrioli<sup>†</sup>

Department of Computer Science, University of Rome La Sapienza

# Structural Health Monitoring



- Structural health monitoring (SHM) in civil engineering is defined as the instrumentation of structures, including buildings, **bridges**, **tunnels**, dams and highways with sensors, and accompanying equipment to assess structural integrity.
- The target is reducing risks and increasing safety of buildings and infrastructures. The risk can be defined as the product of amount of damage multiplied with the probability of occurrence.



# Structural Health Monitoring



- Structural risk management therefore requires the following steps:
  - **Risk evaluation** summarizes possible damages associated to unwanted events (life losses, property damages, negative influence on schedule for construction, financial loss, damage to nature / to reputation etc.) Only recognised risks can be classified and handled. Handling risks normally results in a reduced damage in case of occurrence of the event.
  - **Risk probability** rates the possible occurrence of the listed risks.
  - **Risk classification** includes estimation of the probability of occurrence of a given event combined with the expected damage associated to the event.
  - **Risk handling** implies risk reduction to an acceptable level and elimination of unacceptable risks. It includes identifying in detail the monitoring strategy to be sure that possible risks are early detected and handled when no damage or little damages have occurred.

**LIMITS of current systems: lack of support for cable-less long lasting monitoring**

# GENESI objectives



- *GENESI will develop a new generation of large-scale, **heterogeneous, energy-efficient, situation-aware** wireless sensor networks for structural health monitoring and control which are able to **autonomously operate for several decades** performing **in situ reasoning** and evaluation of potential failures **invisible to current monitoring.***

# GENESI: How it is done



- Enabling a new generation of green wireless sensor networks
  - energy harvesting
  - replacing batteries with fuel cells
  - reduce to the bare minimum energy consumption
    - protocols, algorithms, in network processing
    - radio triggering circuit (Wake-up radio)
- Solving problems which prevents WSN to be brought to the market
  - Reliability/fault tolerance/resiliency to interference
  - Ease deployment and management
    - tools
    - integration with existing middleware and applications for the selected application scenario
- Exploit cooperative sensing/operation
  - adaptive sampling, data aggregation, outlier detection
  - to enrich context understanding

Structural Health Monitoring

# GENESI: Methodology



- Monitoring of a tunnel under construction
- Each monitoring section is constituted by 2 or 3 concrete segments equipped with 6 strain gauges with vibrating string.



- Monitoring during construction of the Poya Bridge in Switzerland



- Simulations
- HW/SW prototypes and demonstrators



- Implementation
- Lab/small scale tests

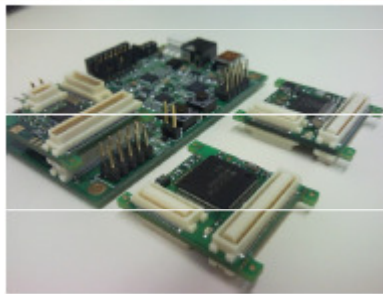


- Real-life test-beds

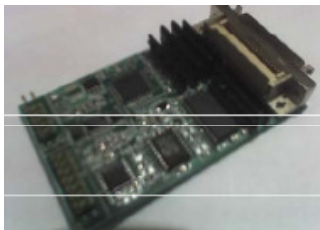
# GENESI Achievements



Our platforms

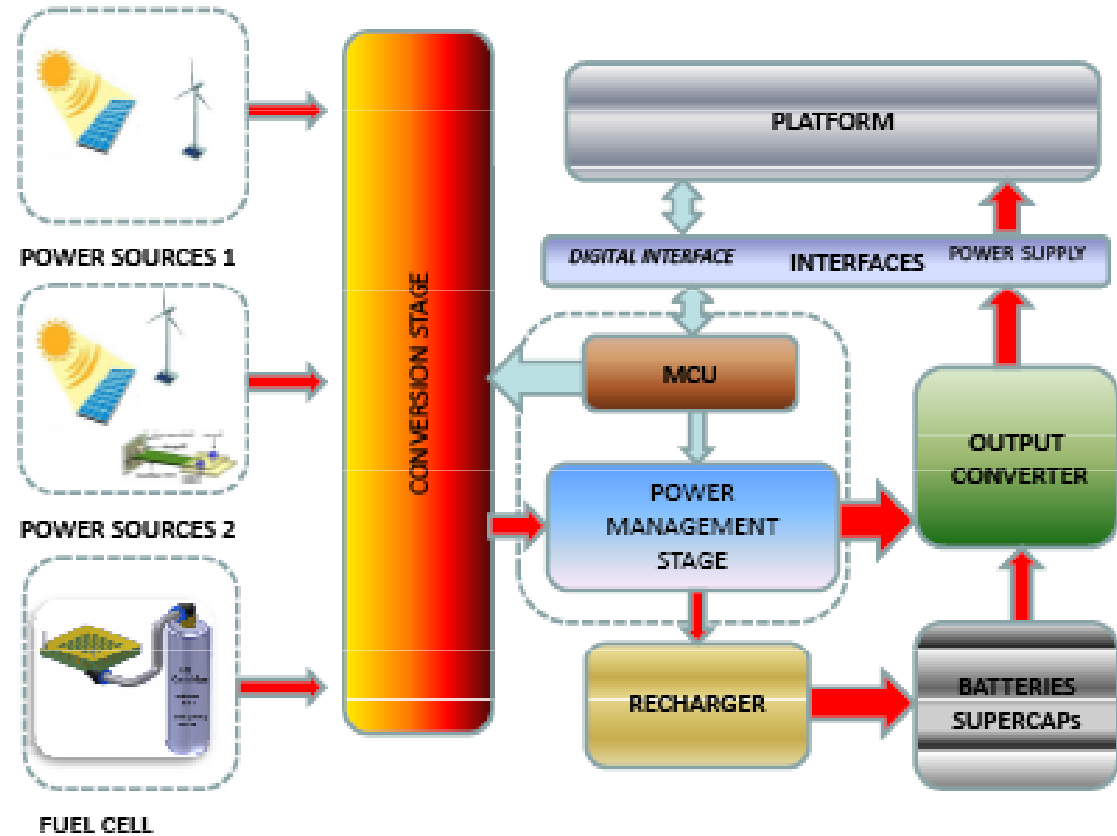


Interfaces with SHM Sensors



Strain gauges,  
inclinometers

GENESI node

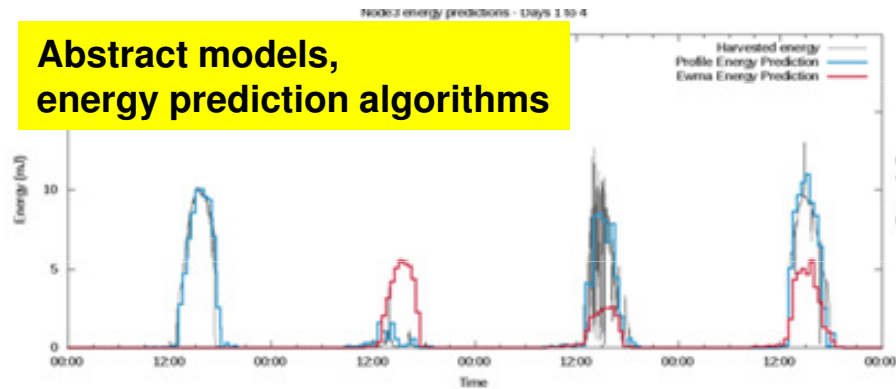


Multi source energy harvesting  
Smart power unit  
Radio triggering circuit

# GENESI Achievements

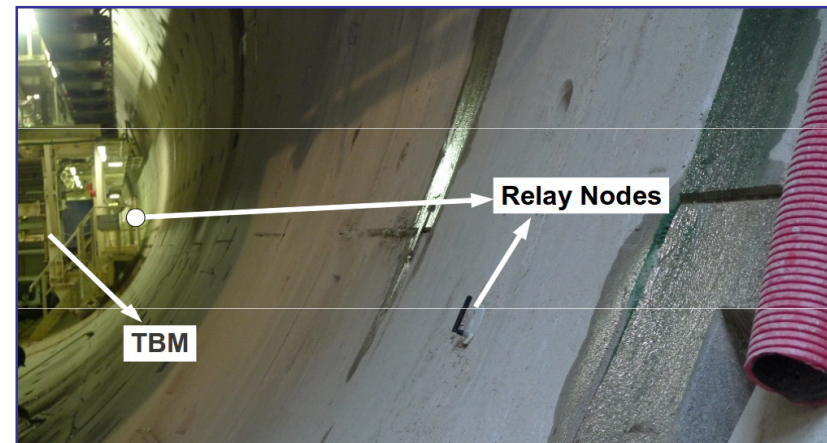
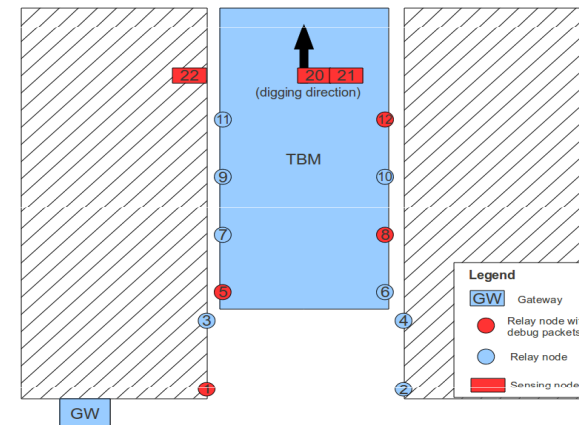


## Abstract models, energy prediction algorithms



- Energy harvesting aware, distributed
  - ✓ Task allocation and selective activation
- Low power protocol stacks
  - radio triggering and energy harvesting aware protocol stack being finalized
- Distributed outlier detection
- QoS aware adaptive sampling

## In field test of a first complete solution for monitoring of a tunnel in the excavation phase







# Questions?

Contacts:

Prof. Chiara Petrioli  
University of Rome La Sapienza

[petrioli@di.uniroma1.it](mailto:petrioli@di.uniroma1.it)

SENSES lab: [http://reti.dsi.uniroma1.it/SENSES\\_lab/index.html](http://reti.dsi.uniroma1.it/SENSES_lab/index.html)