GENESI WP6:
Achievements in the deployments
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Objectives

a) **Evaluation** of the solutions proposed by the individual WPs
   Identify performance metrics and benchmarks
   -> identification of “champions” for each GENESI technology

b) **Integration** of the different components to the GENESI SHM system (mix lab and site experimentation)

c) **Implementation** of GENESI in real-life test beds (Metro Roma and Pont de la Poya)

d) **Validation** of the new GENESI system in the field
The total length of the B1 line of Rome underground is about 5 Km and B1 line consists of four new underground metro stations. For the GENESI project, the tunnel under construction, namely the GL50 tunnel, is monitored by a set of Vibrating Wire Strain Gauges (red lines) placed in no.4 different tunnel sections, to which Genesi sensor nodes are applied. The GL50 tunnel is a single tunnel (approx. 1.2km length and 9.8m diameter) that connects the Jonio station to the Conca d'Oro one.
The strain gauges for concrete are used to measure the strain, and to define the stress status inside the final lining of the tunnels. The strain gauges are installed on the steel supporting structures of the precast segments of the final lining.

One ring of tunnel final lining consists of no.8 concrete segments.
The concrete segments for the no.4 GENESI monitored sections have been prepared, on June 2011, at the Cancellotti Spa facility in Perugia (Italy).

Concrete segments of tunnel final lining.
Vibrating-wire strain gauges are used to monitor the concrete and steel deformation and they are commonly used in SHM, especially for tunnel constructions, to evaluate the stability of the tunnel and its expected shape deformation.

Strain gauges are fixed by steel wires on the metal supporting structures of the segment.

Each segment is equipped with no. 6 strain sensors and a steel box (20cmx13cmx24cm) for the GENESI wireless sensor housing.
The Genesi monitoring sections replicate the same type of monitoring system interleaving the commercial instrumented sections envisioned for monitoring the MetroB1 tunnel.
This methodological approach has the twofold advantage of

a) allowing us to benchmark GENESI system with commercial systems, validating our approach and quantifying performance improvements;

b) clarifying which are the additional functionalities which GENESI system can provide over commercial systems.
All the data generated by the GENESI sensors must be recovered through a manual procedure, thus, while some data can be lost during the automatic data acquisition, there must be a way to manually recover all the data from sensors.
The GENESI wireless test-bed is made of a Wireless Sensor Network (WSN) that collects data from the strain sensors installed in the instrumented segment and stores them remotely to an external server. To this aim, the gateway is made of a wireless node, acting as a sink for the WSN.
The gateway is responsible to collect data generated by the deployed network and transmit it to an external server where data are stored and processed.
The Sensing Node is the wireless node which substitutes the data-logger of the wired solution. The Sensing Node is put inside a steel box (20cmx13cmx24cm).

Ready-installed Sensing Nodes in the tunnel lining (next to tunnel boring machine)
The Relay Node is a wireless node which supports the multi-hop forwarding of data toward the Sink. Its goal is to provide wireless connectivity to the sensing nodes.

The Relay Debug Node is a relay node which also generates debug data that is forwarded to the gateway in the same way as it is done by the Sensing Node. Its goal is to provide useful debug information of the running test-bed.
EXAMPLE OF TEMPERATURE DATA ACQUIRED FROM “E” SEGMENT OF THE FIRST GENESI MONITORING SECTION

TEMPERATURE VS TIME

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<tr>
<th>Concessionaria</th>
<th>ROMA METROPOLITANE S.p.A.</th>
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<td>Affidataria lavori</td>
<td>Società Consortile METRO B1 a r.l.</td>
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<td>Commessa</td>
<td>Metropolitane di Roma - Linea B1 - Direzione Linea B - P.zza Bologna - P.zza Conca d’Oro</td>
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I SEZIONE GENESI - Anello 150 concio E - BARRETTE ESTENSOMETRICHE PER CLS
RESULTS IN THE TEST-BED

• Low impact on construction works (quicker installation)
• Economical gain
• Reading can start earlier than with traditional systems
• In the tunnel the connectivity is good enough (better than open air environment); the distance between two relay nodes is about 50-80 m. Instead the connectivity of nodes inside the concrete (Sensing nodes) decreases to ca. 20 m.
• The reliability as demanded could be achieved
• System can be easily extended
Deployment Pont de la Poya
Pont de la Poya

Traffic bypass for the historic city of Fribourg
Pont de la Poya

Traffic bypass for the historic city of Fribourg
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Traffic bypass for the historic city of Fribourg
**Pont de la Poya**

### Technical data
- Overall length is approx. 1.5 km, whereof 300 m in tunnel section and 850 m suspension bridge

- Crossing valley of the Saane at an average height of 70 metres above

- Bridge bases on 10 pillars and 2 pylons reaching a height of 110 metres

- Main distance between the pylons is 196 metres

- The viaduct directly connects into the Palatinat tunnel portal and then crosses below the major railway line from Berne to Lausanne.

### Environment
- Altitude above sea approx. 800 m in the Swiss Alps
- Temperatures -30°C to +40°C
- Strong winds, snow, rain, fog