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Use of Wireless Sensor Networks for landslide monitoring

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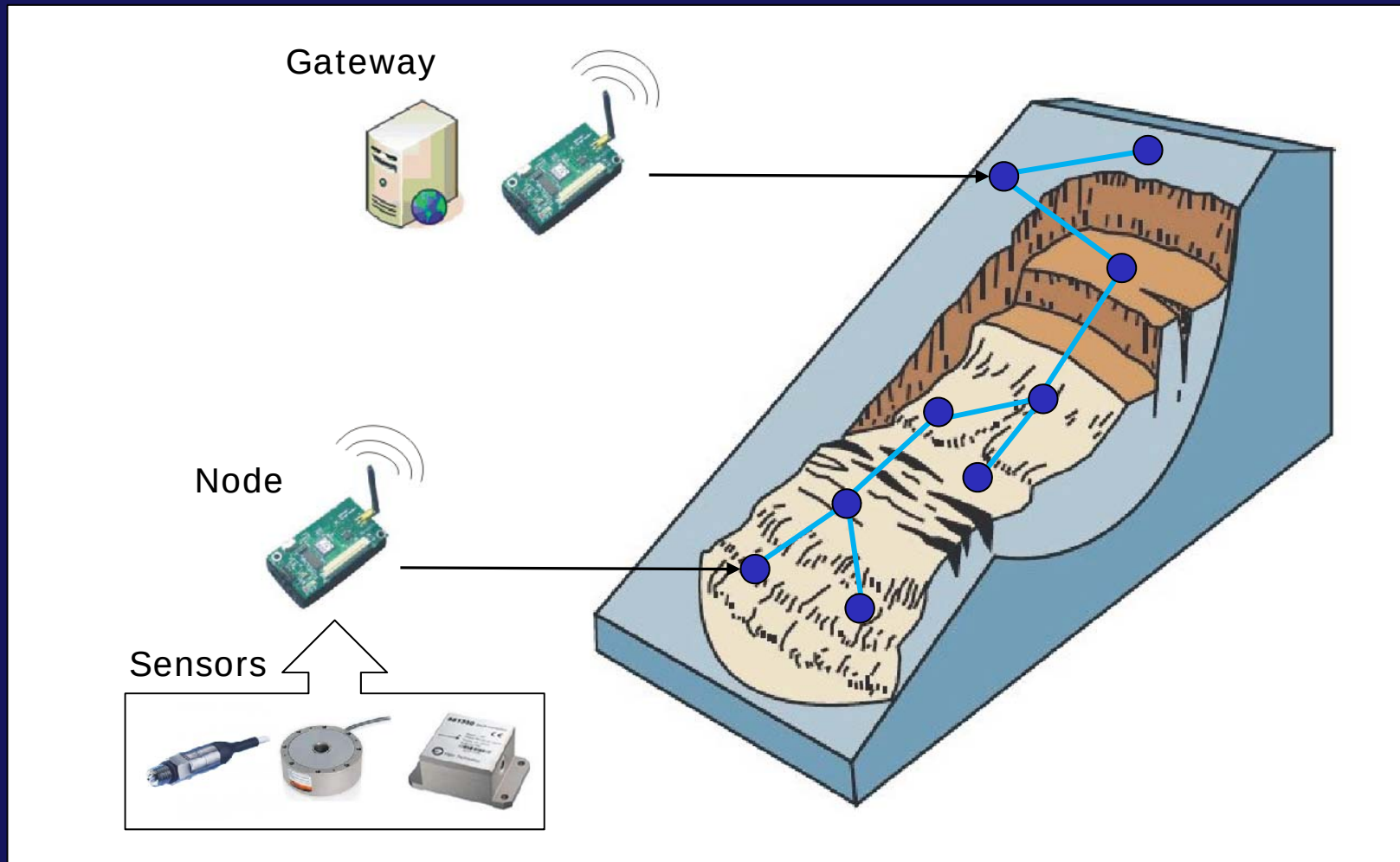
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Franco Zambonelli



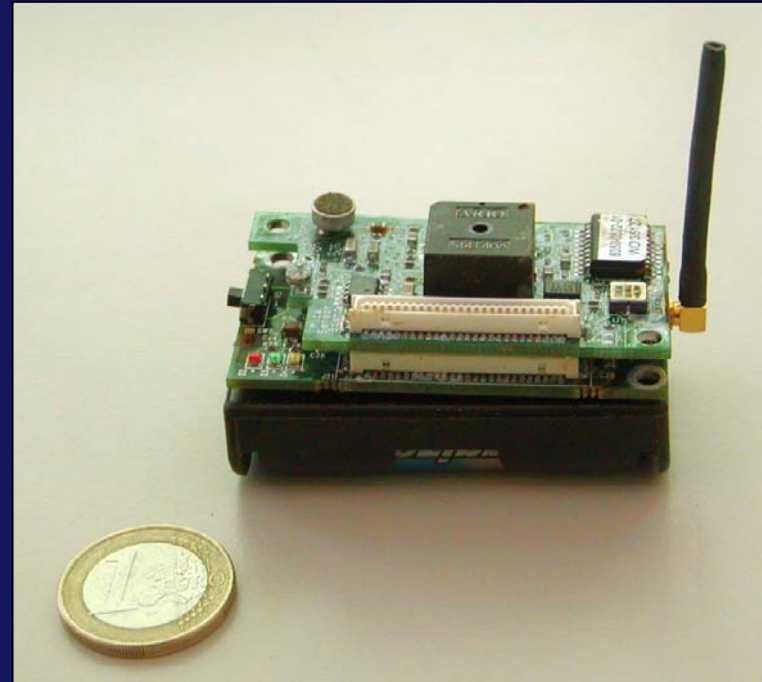
What is a Wireless Sensor Network ?

A Wireless Sensor Network consists of a network of spatially distributed computer-based sensor nodes with a wireless communication module



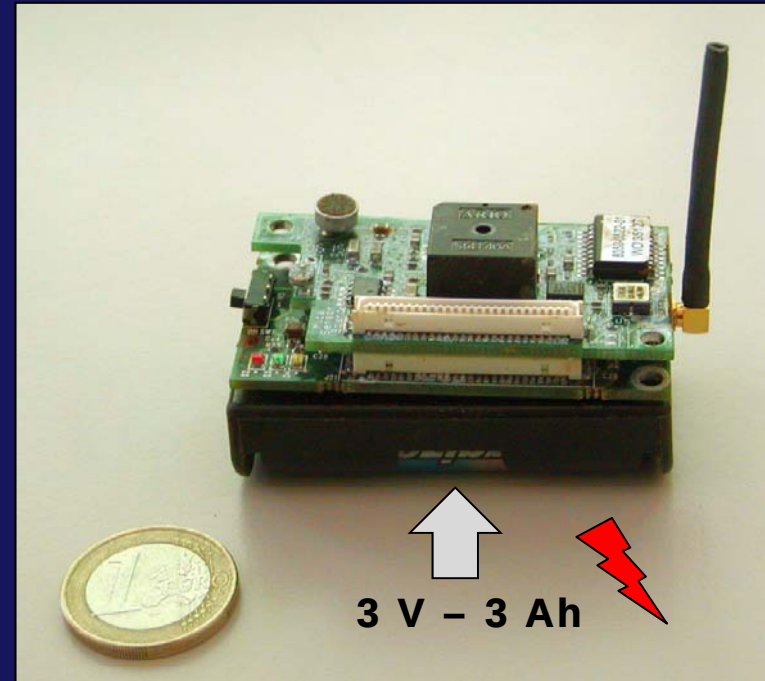
Features and potential advantages

- Small and light
- Low power consumption
- Connect any type of sensor
- Dynamic routing
- Cheap



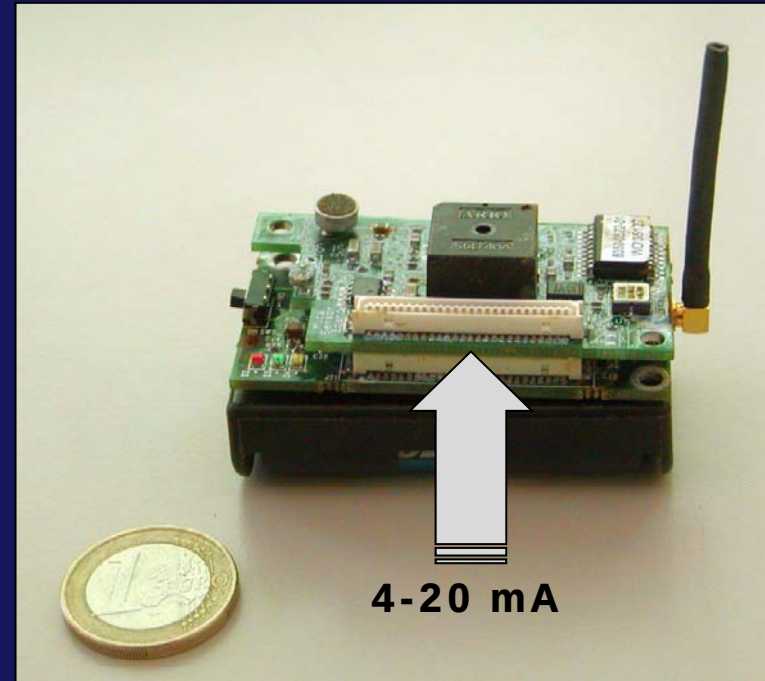
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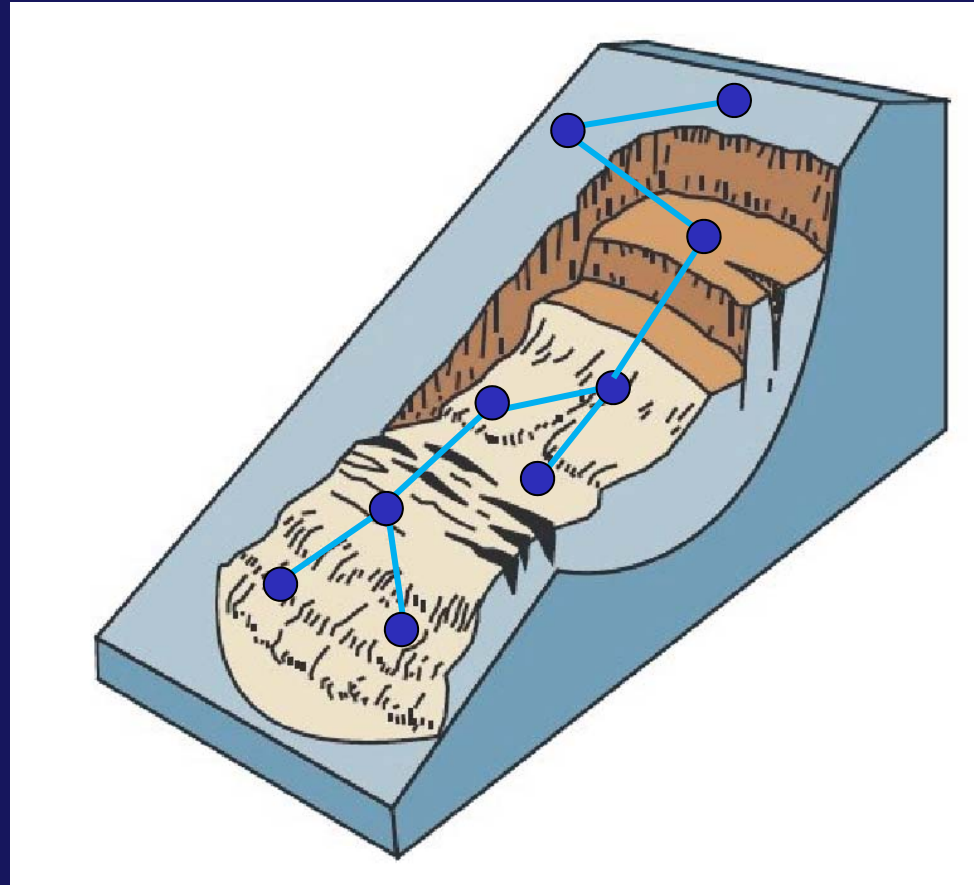
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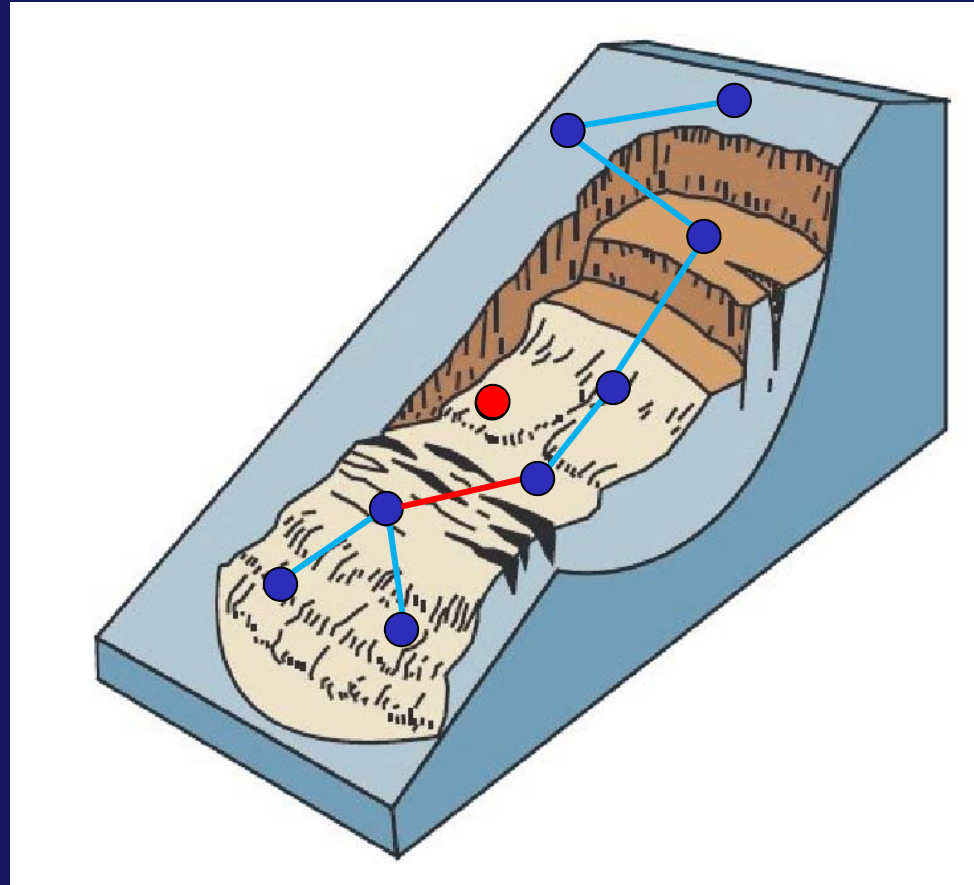
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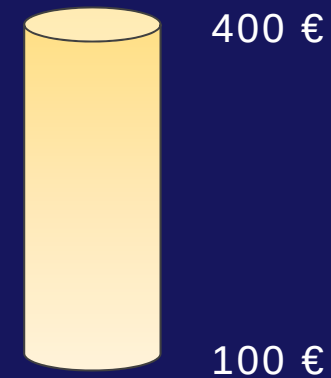
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Features and potential advantages

- Small and light
- Low power consumption
- Connect any type of sensor
- Dynamic routing
- Cost-effective

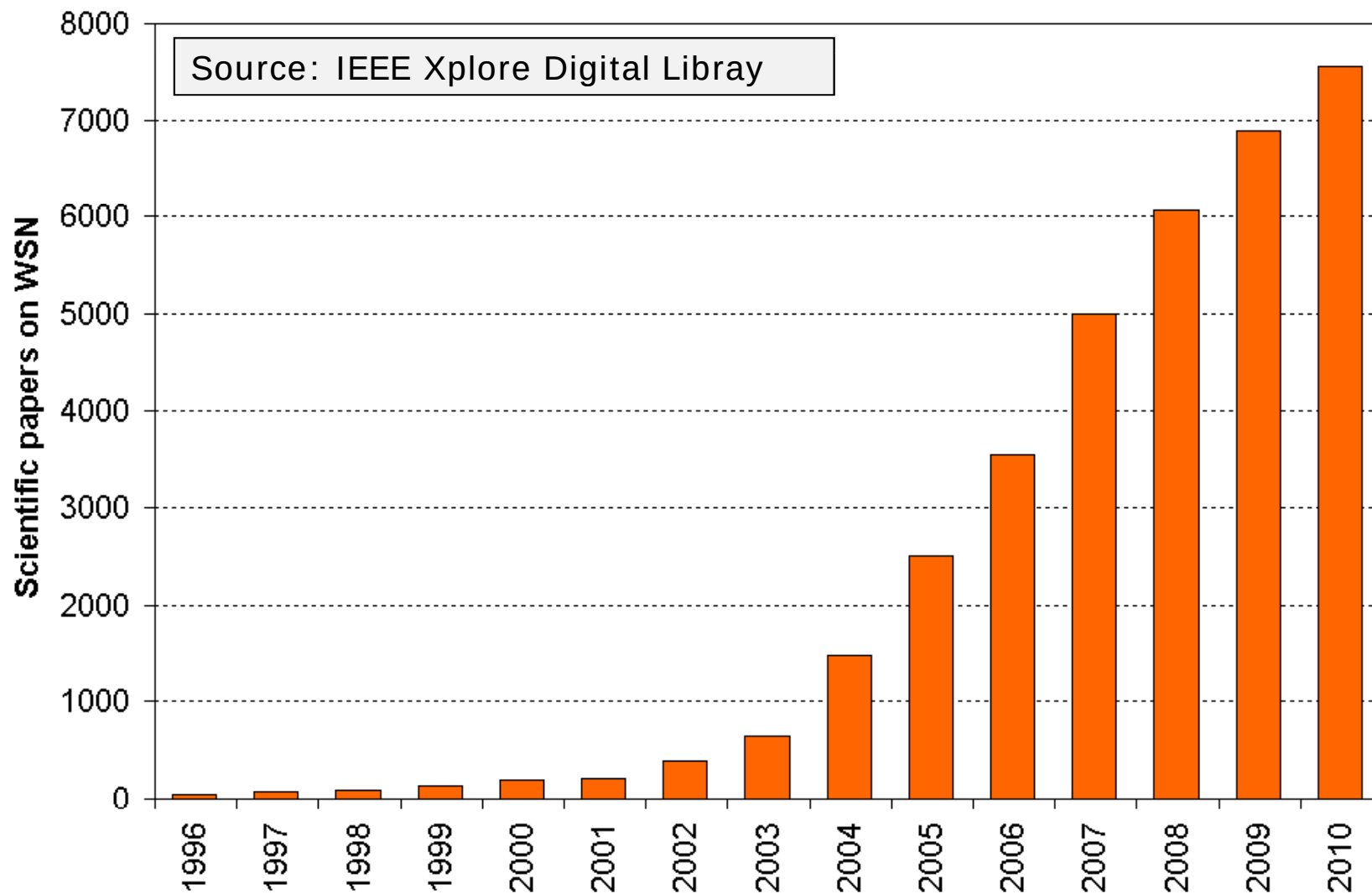
Typical cost of a single node



“ Wireless sensor nodes are expected to drop in price to less than 5 dollar each over the next five years “

Aberer, EUROSCOM 2006

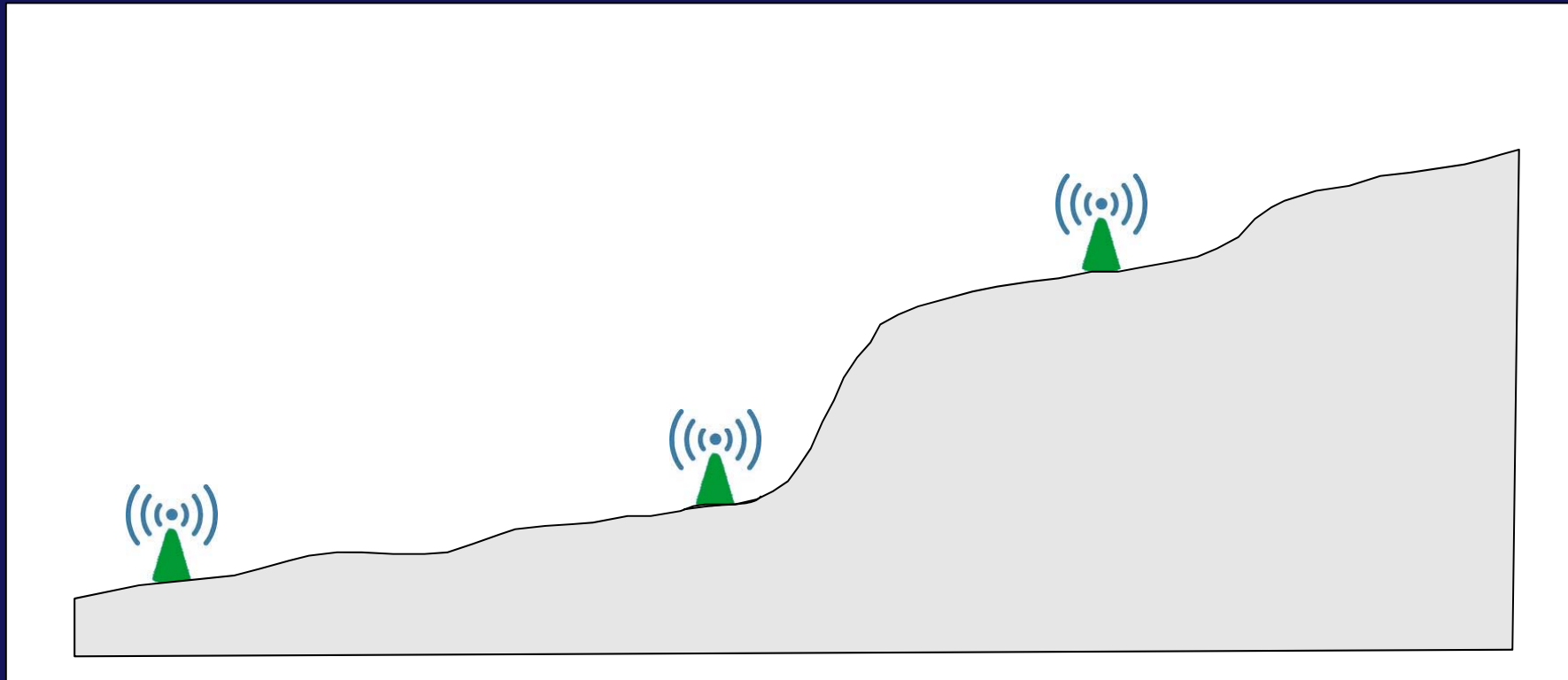
A growing interest..



Advertising Vs Reality: field testing (2007-08)

High power consumption:

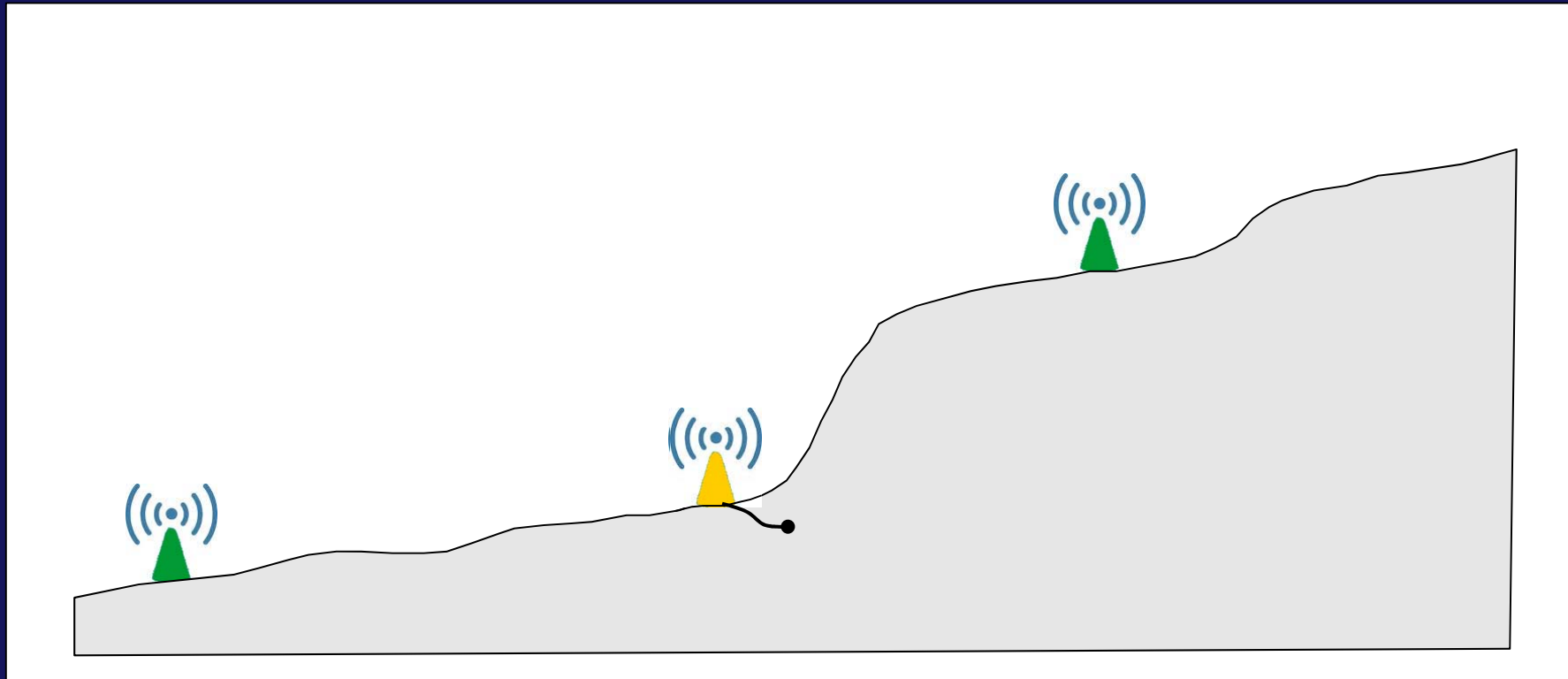
- sensor supply
- increased transmit power
- bridge nodes



Advertising Vs Reality: field testing (2007-08)

High power consumption:

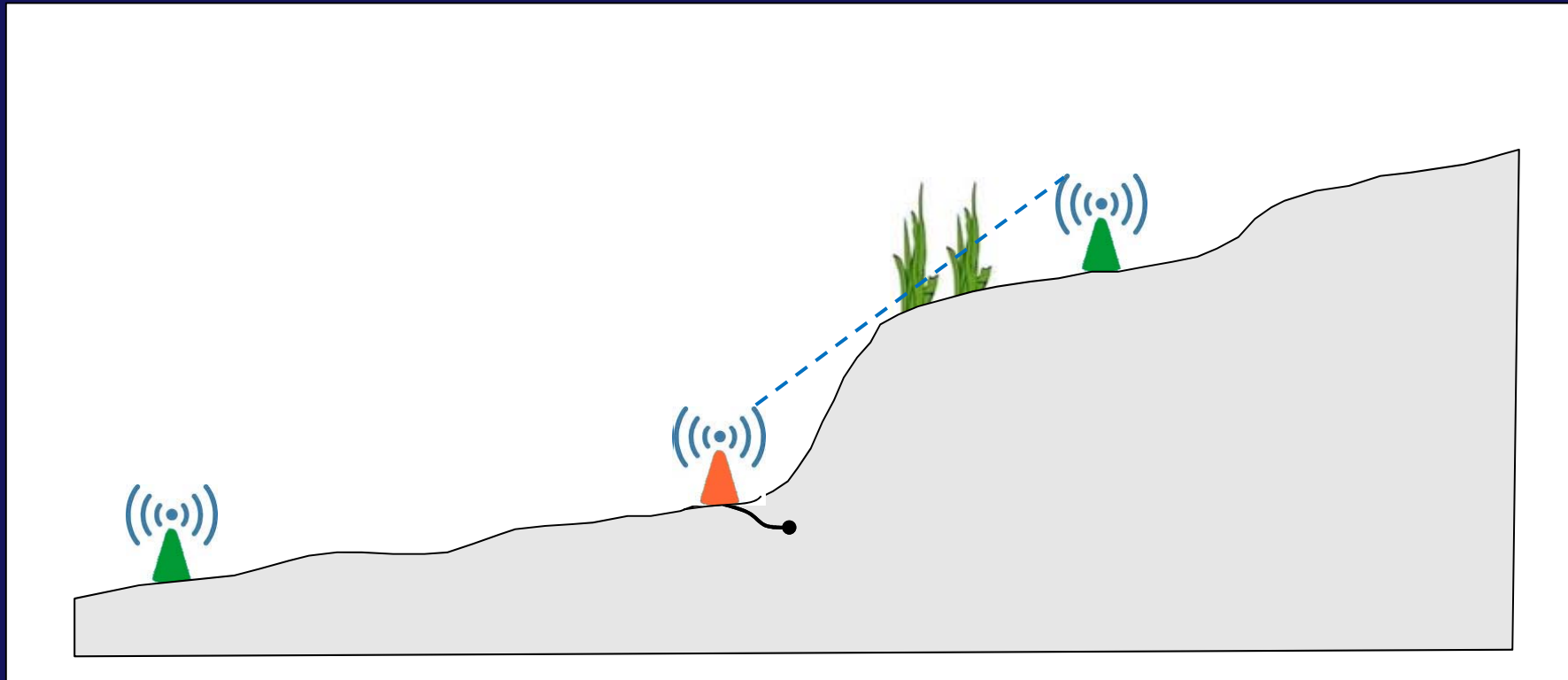
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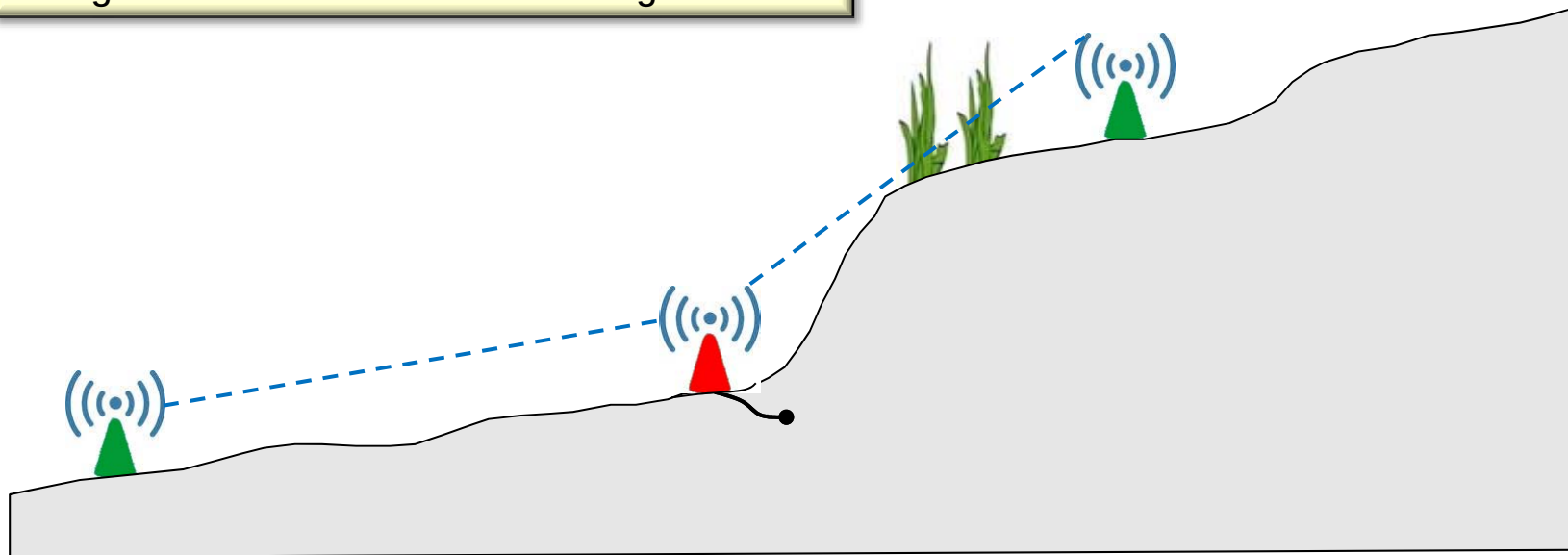
Advertising Vs Reality: field testing (2007-08)

High power consumption:

- sensor supply
- increased transmit power
- bridge nodes

- low battery duration (7-10 days)
- frequent maintenance (weekly)
- limited nodes distance (30-40 m)

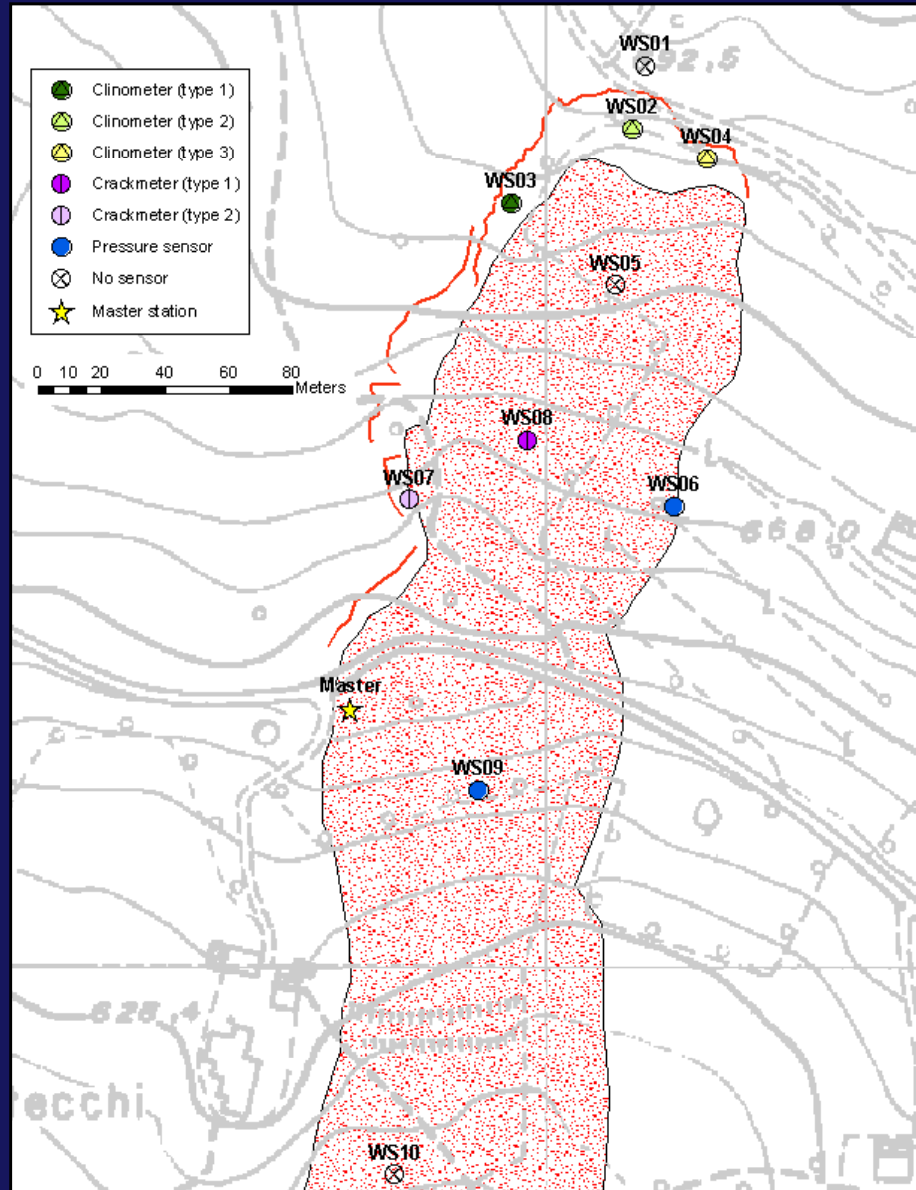
Development of new hardware specifically designed for landslide monitoring



New WSN hardware (WISELAND Research Project)

Technical characteristics			
		CAE	Embit
Wireless technology		802.15.4 modified	IEEE802.15.5/ZigBee
Routing protocol		Dynamic	Static
Power supply		3 Lithium batteries (3.6V 16.5Ah) in parallel	1 Lithium Thionyl Chloride battery (3.6V, 19Ah)
Built-in sensors	Number	3	1
	Type	Battery Voltage Air Temperature MEMS	Battery Voltage
External sensors	Analog input range	4-20 mA / 0-2 V	4-20 mA
	Ports	3	2
	Power supply	12V	12V
Radio	Frequency	2.4 GHz	2.4 GHz
	Antenna	Omnidirectional	PIFA/U.FL conn.
Outdoor range		400 m	400 m
Life expectancy		6 months	6 months
Remote settings		Yes	Yes

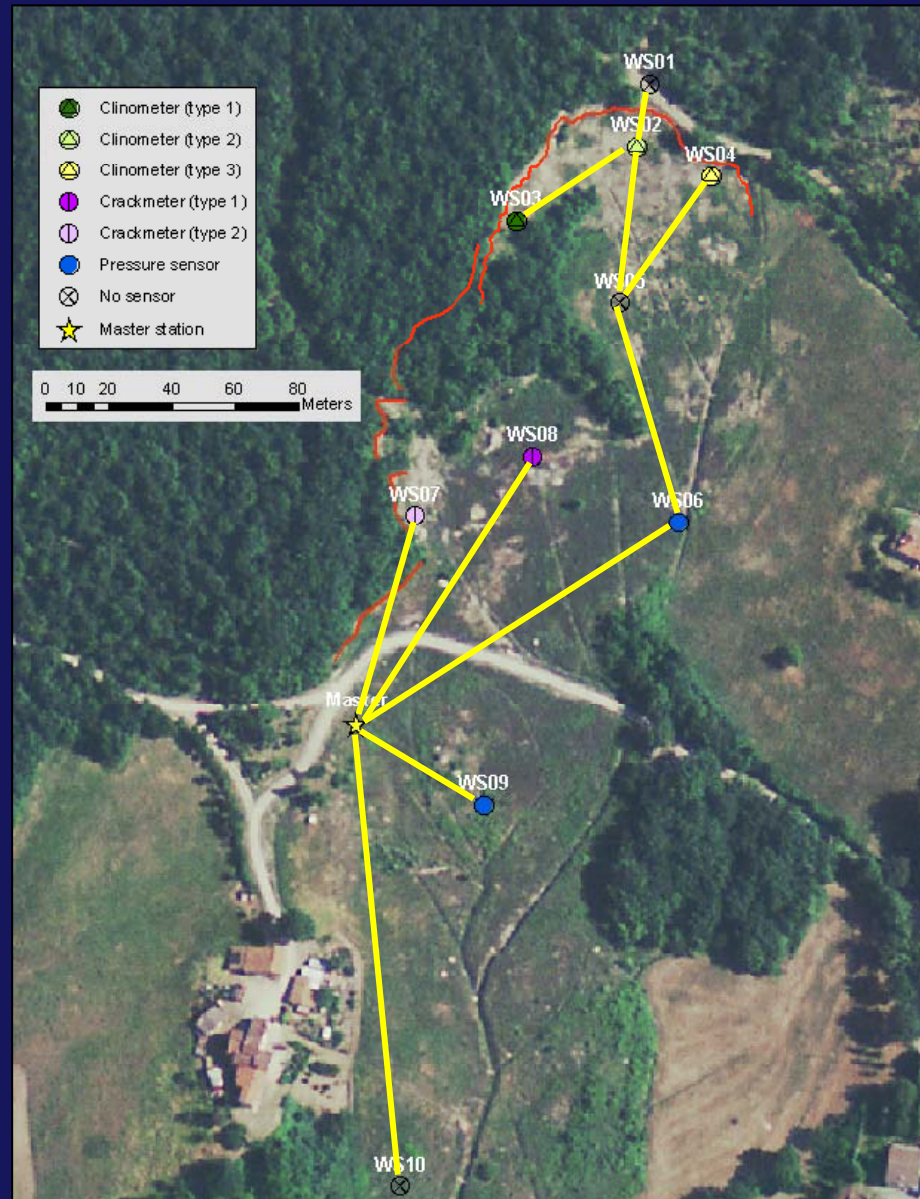
Field deployment at Silla landslide (CAE system)



The Silla landslide

- Installation: 19 April 2010
- 10 WSN nodes (7 conn. to sensors)
- Network configuration: dynamic
- Max distance: 100 m
- Sampling time: 30 minutes
- Master station with radio connection

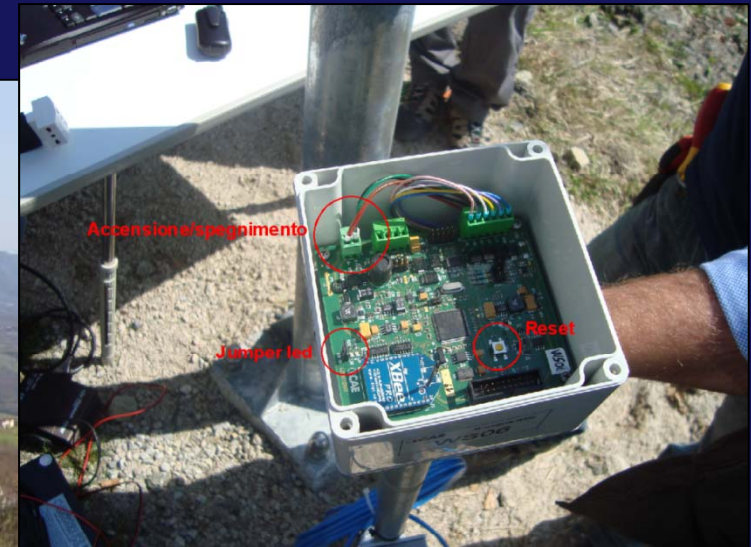
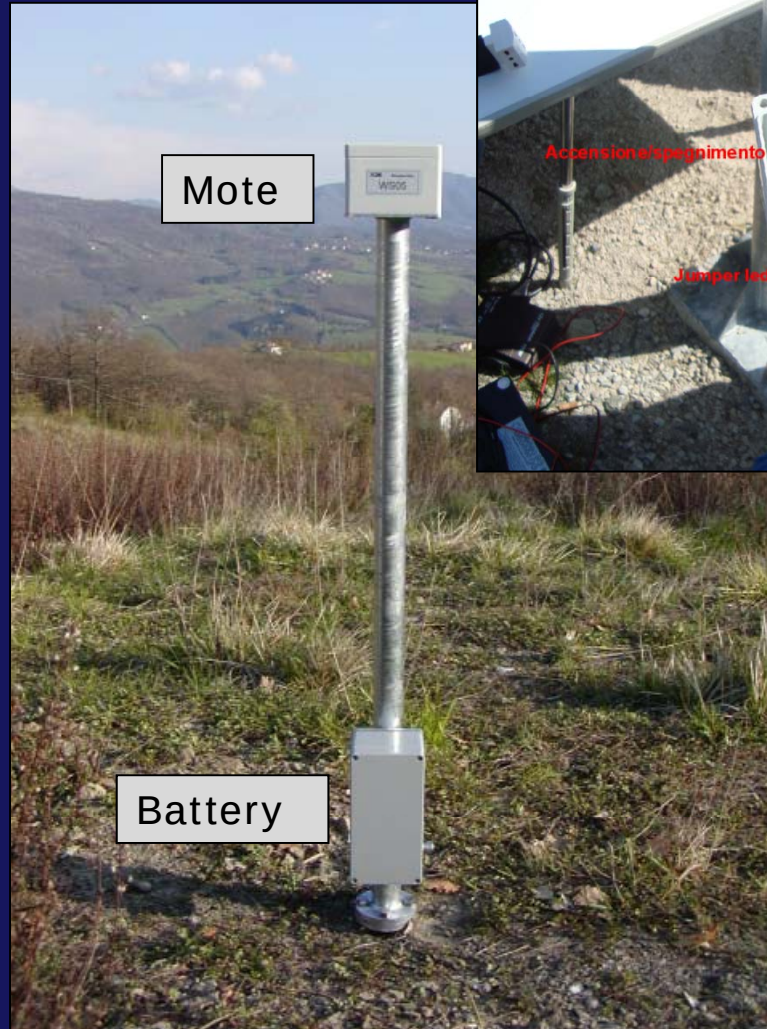
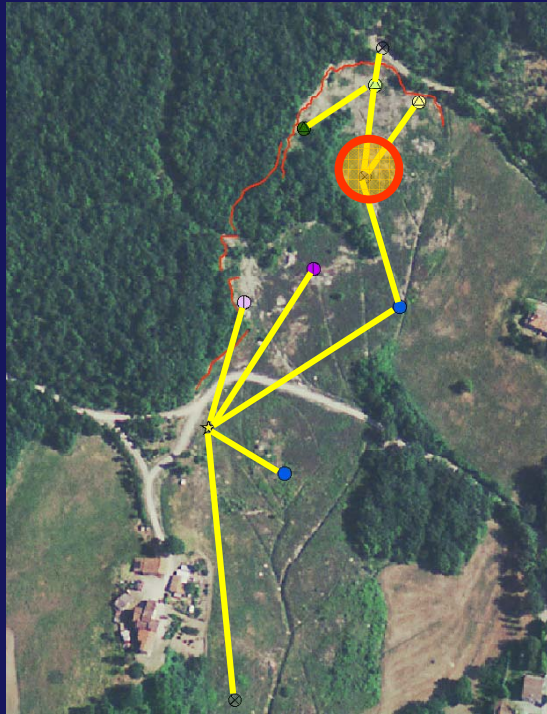
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The Silla landslide

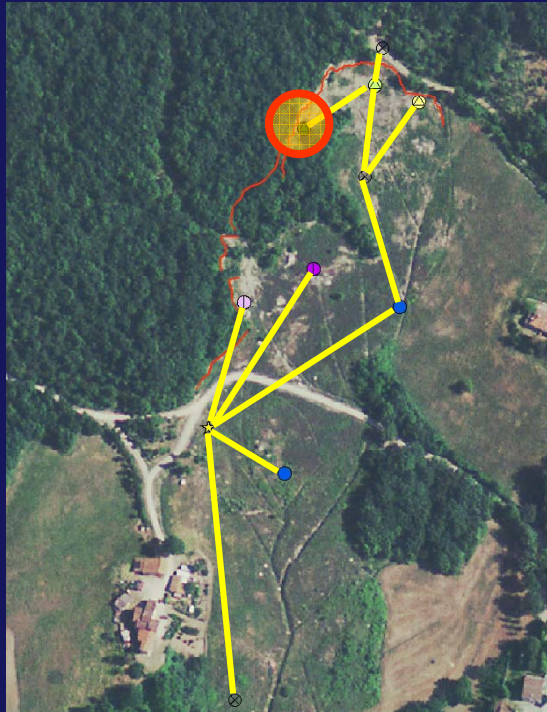
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Field deployment at Silla landslide



Node WS05 (no sensor)

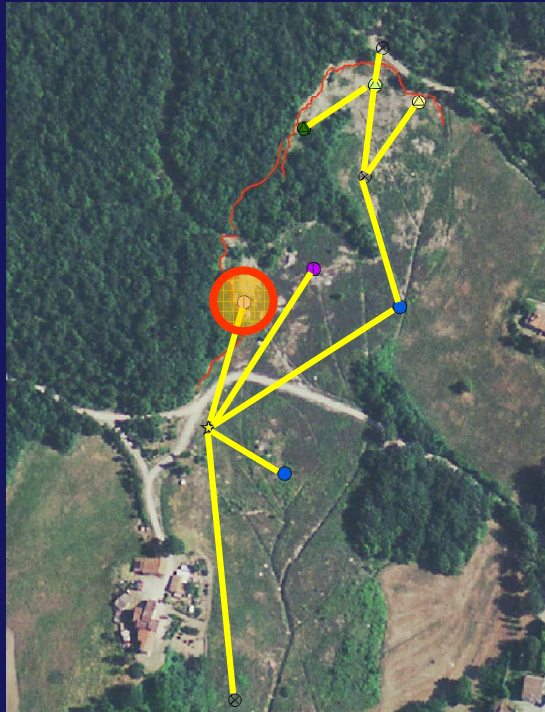
Field deployment at Silla landslide



Node WS03 (clinometer)

Field deployment at Silla landslide

Silla landslide



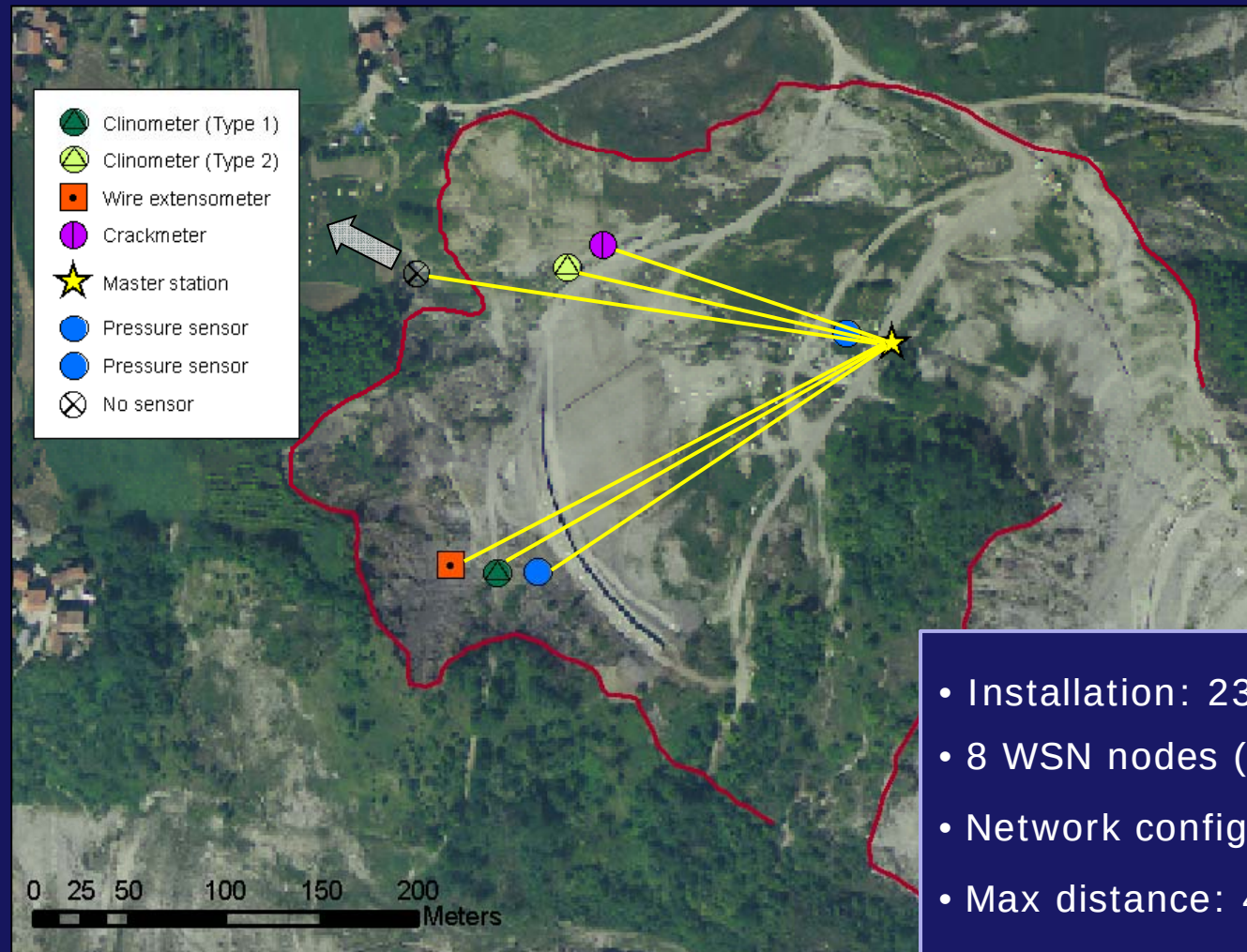
Node WS07 (crackmeter)

Field deployment at Calita landslide

The Calita landslide

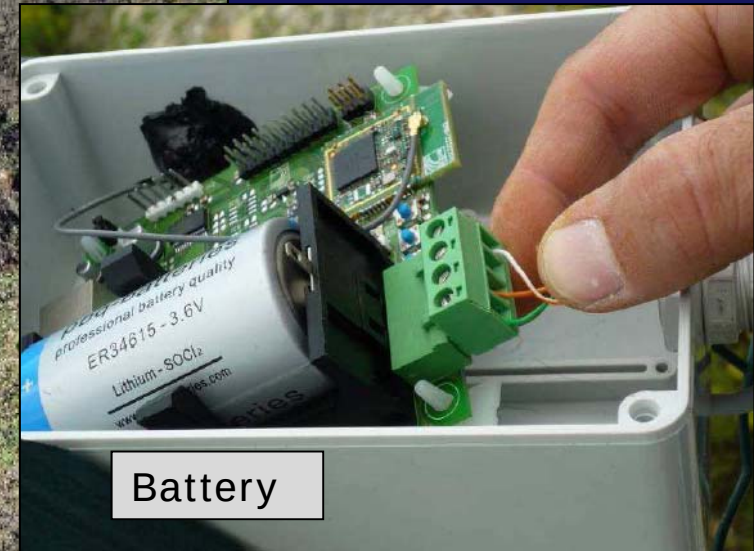
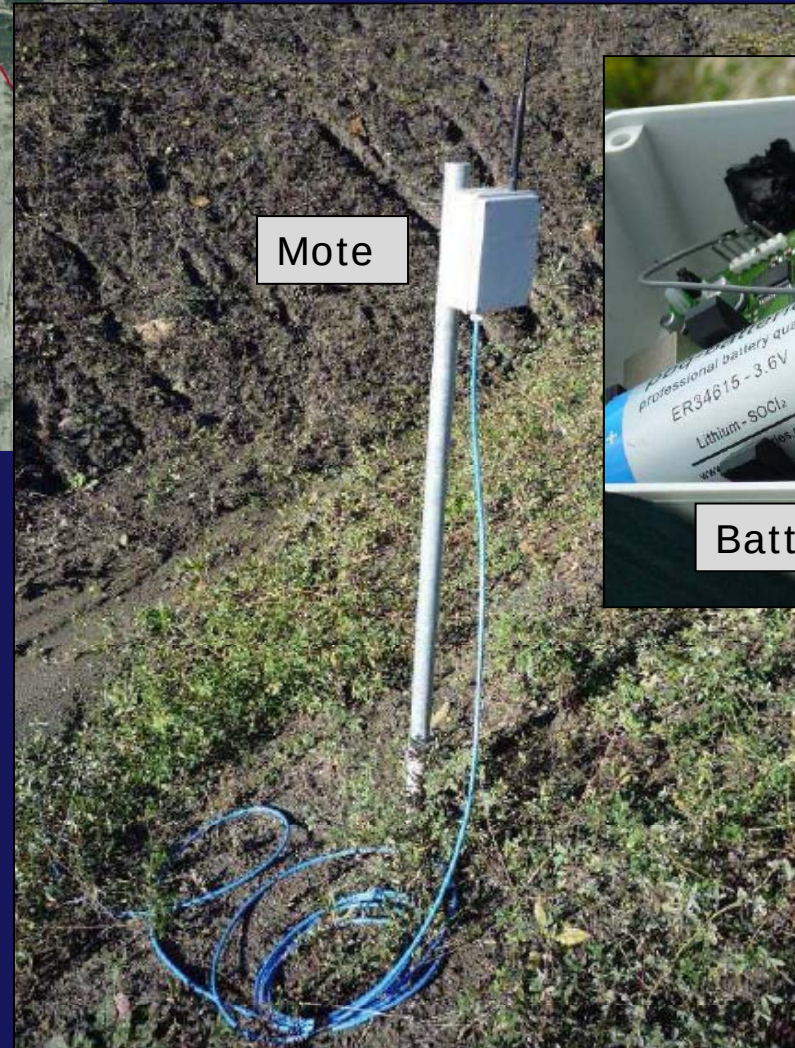


Field deployment at Calita landslide



- Installation: 23 July 2010
- 8 WSN nodes (6 conn. to sensors)
- Network configuration: star/static
- Max distance: 400 m
- Sampling time: 1 hour
- Master station with GPRS connection

Field deployment at Calita landslide

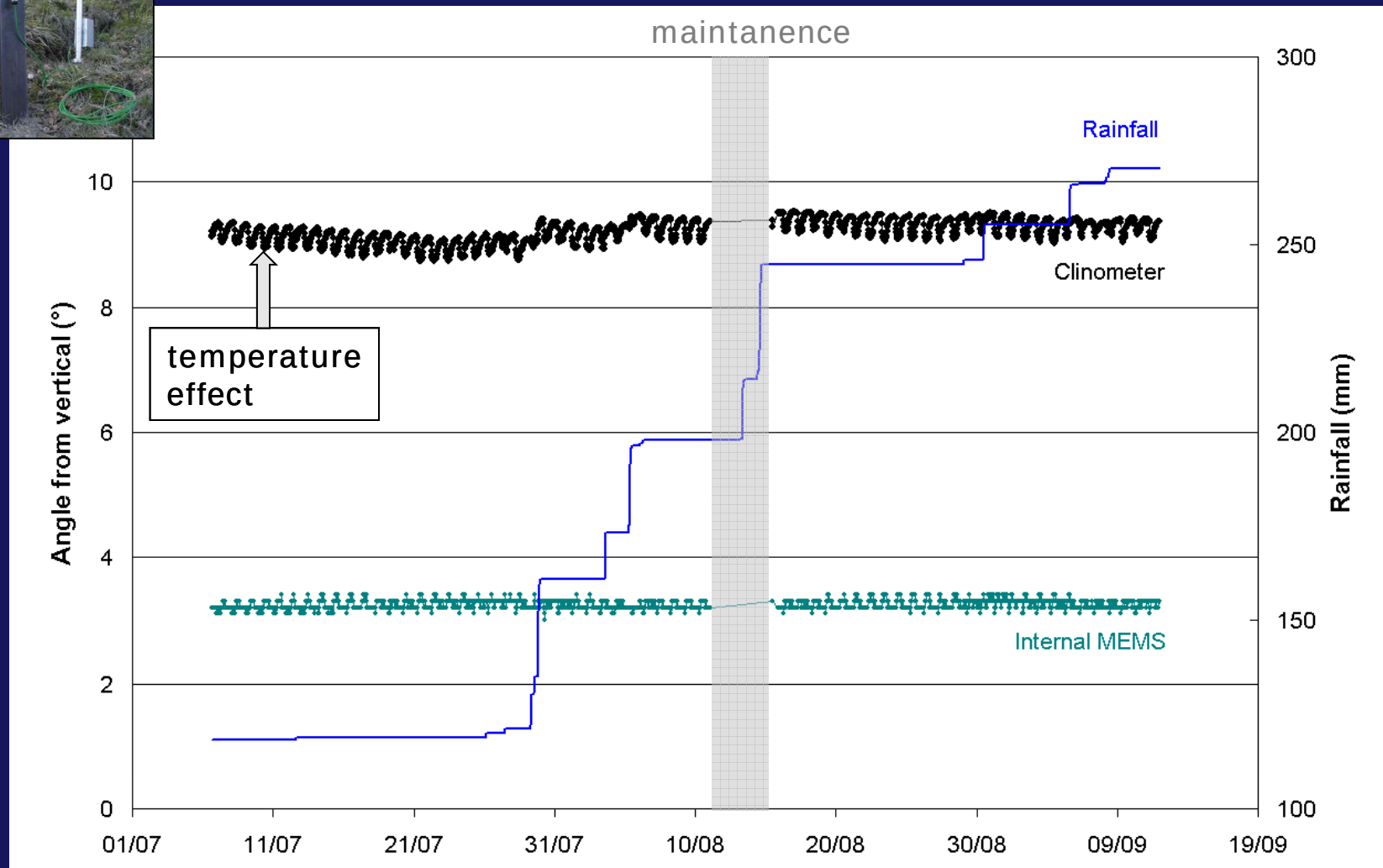


Node WS03 (pressure sensor)

Sample data



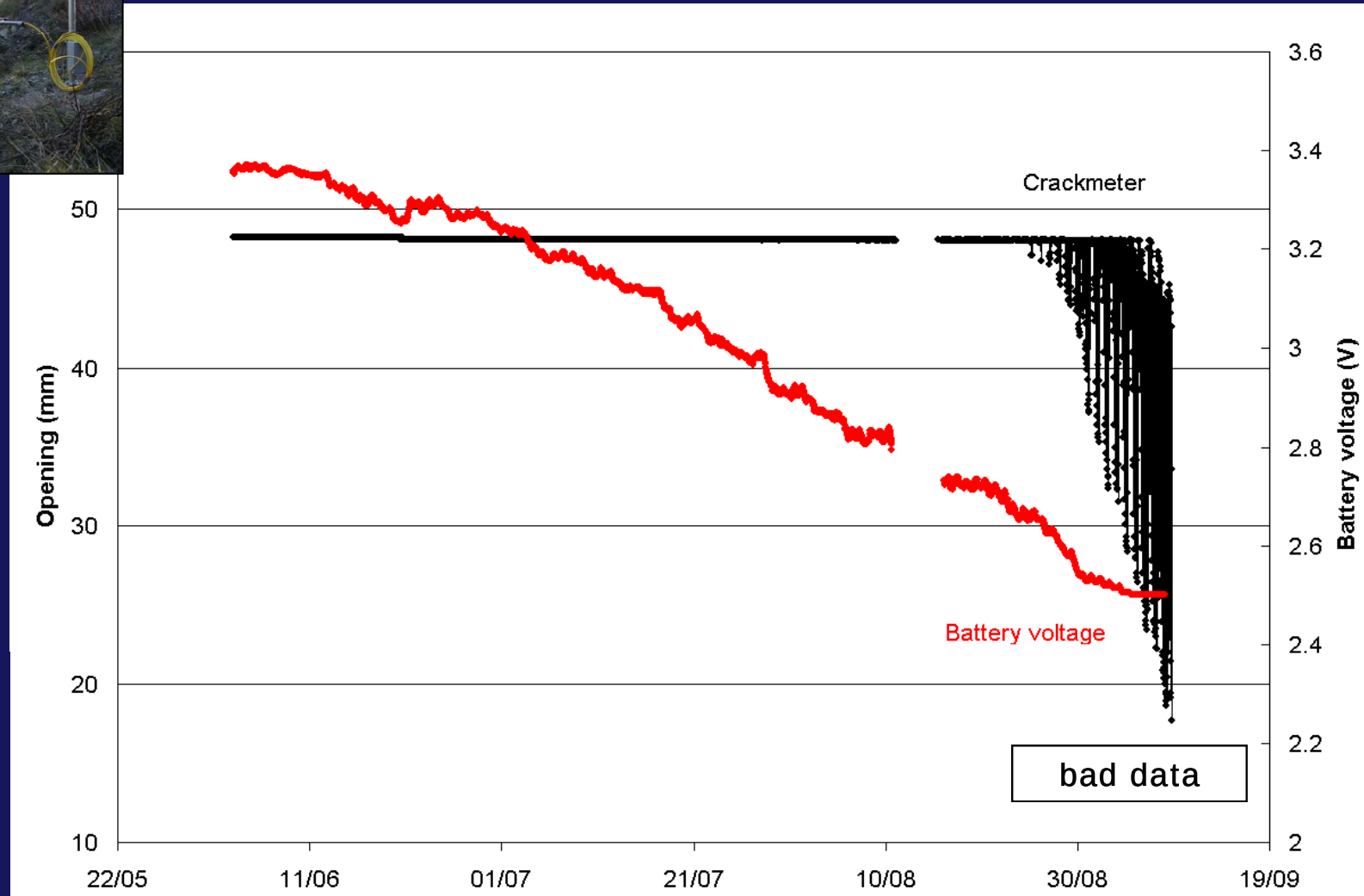
Silla landslide node WS03



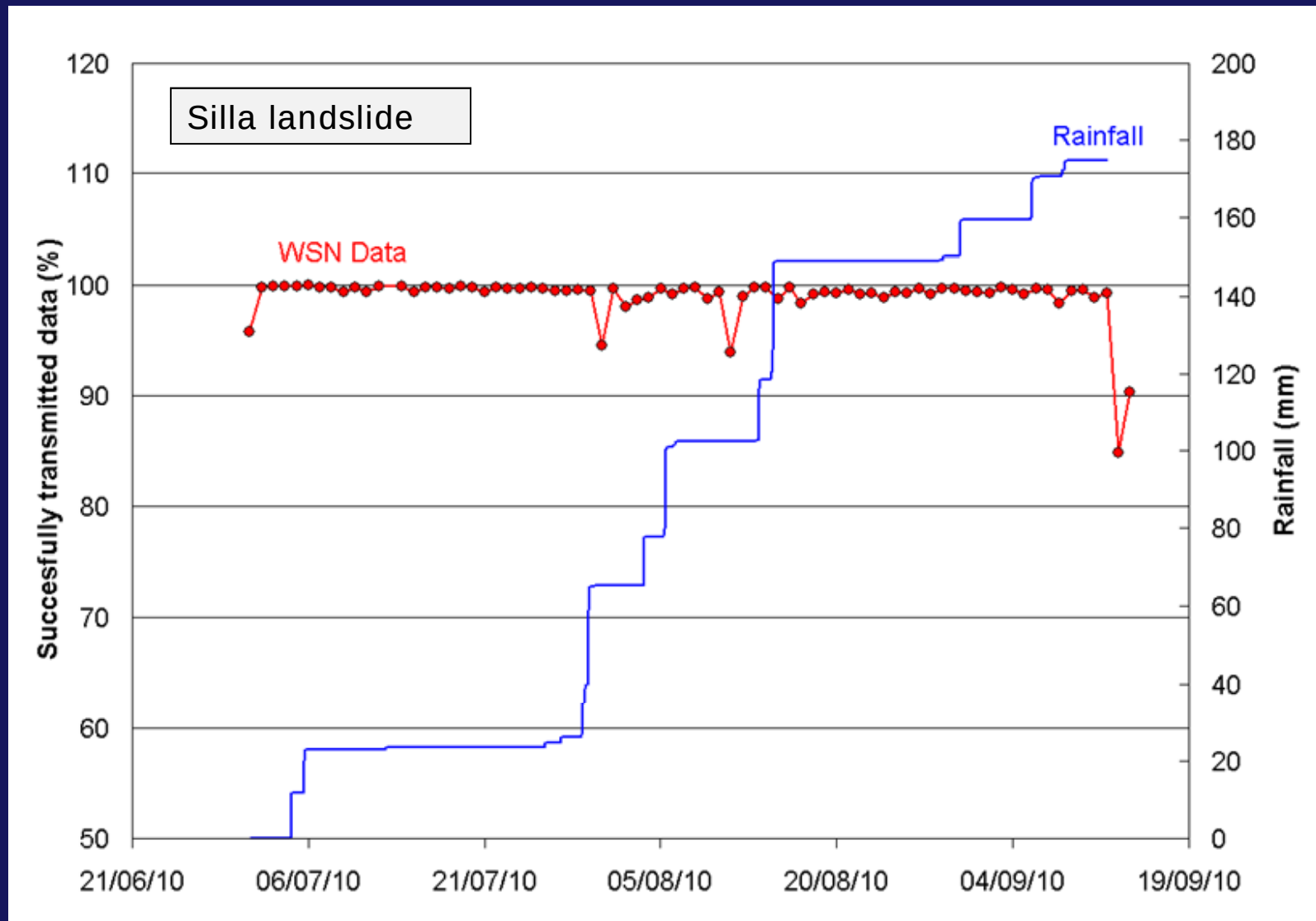
Sample data



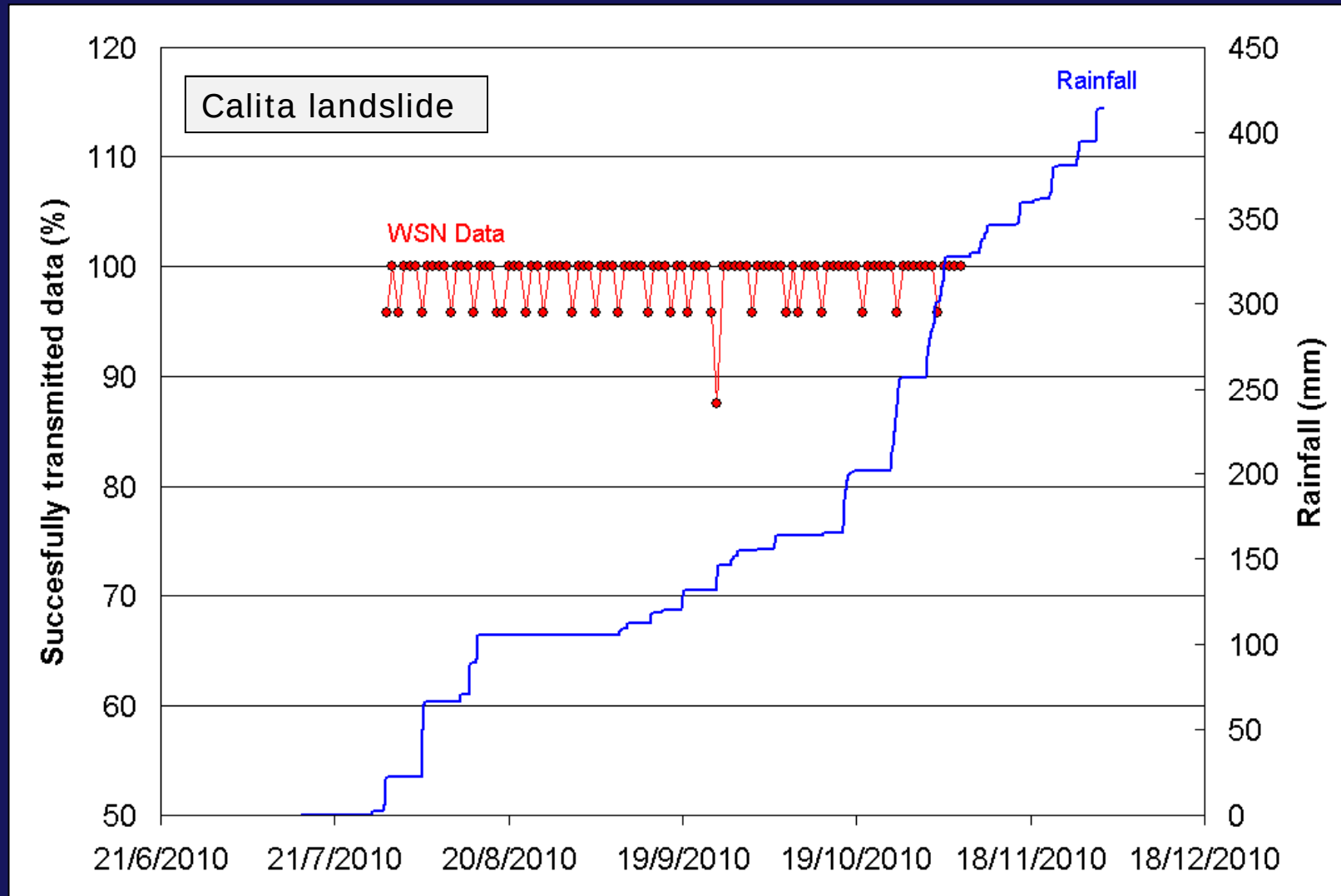
Silla landslide node WS07



Performance of the Wireless Sensor Network



Performance of the Wireless Sensor Network



Conclusions

Lessons from field testing:

- Installation is quick and easy (10 nodes + master station in 6-8 hours)
- Wireless data transmission is reliable (success rate >95%)
- Long node-node distance range (up to 300-400 m)
- Few failures, low maintenance
- Good duration (approx. 3 months) **but less than expected**

