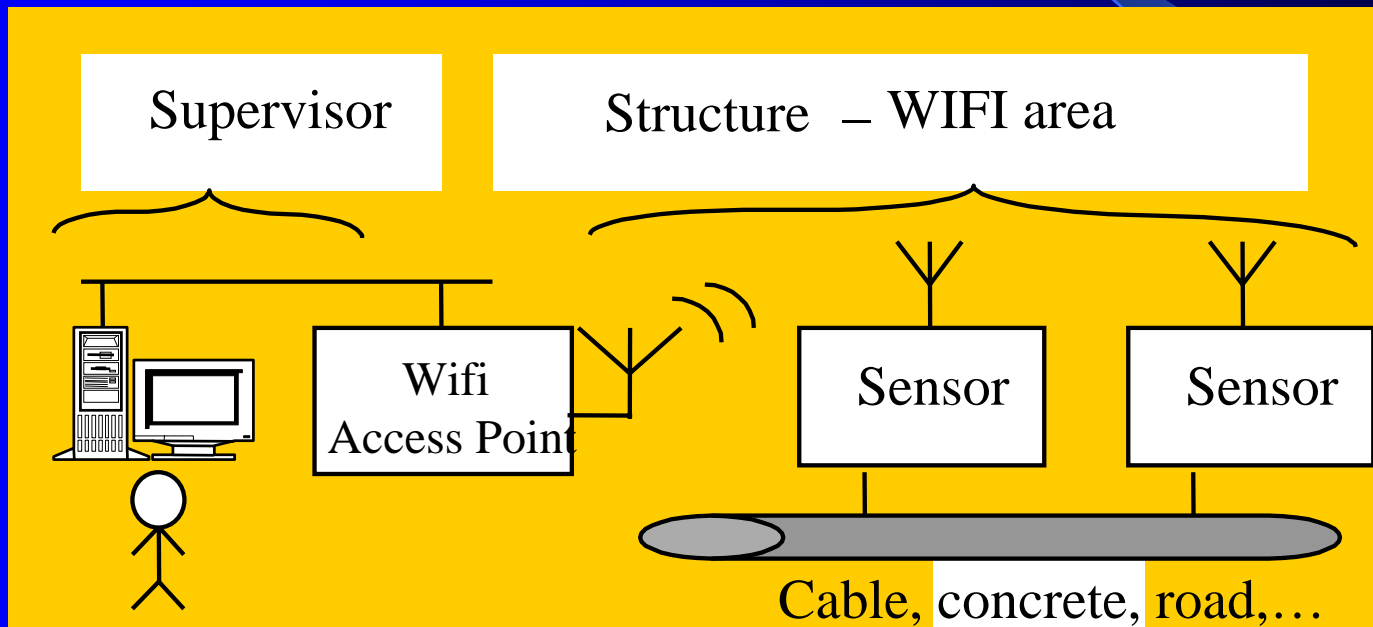


LCPC Wireless platform description

LCPC developed such a wireless sensor network platform with the following characteristics : **the platform is a “N sensors 1 supervisor” distributed network.**



Sensors are seen like the computers of a traditional computer network

LCPC Wireless platform description

LCPC wireless platform elements description :

- Network communication
- Smart sensor
- Supervisor

Real case applications



LCPC Wireless platform description

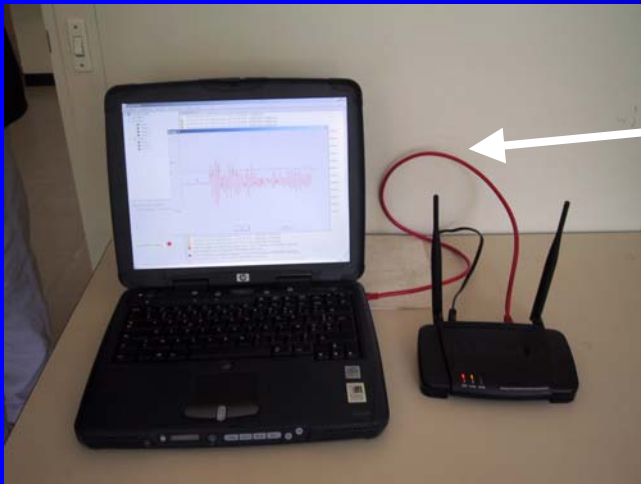
Network communication : TCP/IP

Wireless implementation of TCP/IP exists : WIFI (802.11x)

TCP/IP is an open-source low-cost world-wide protocol

Embeddable and customizable in small electronic components

Wifi are easily adaptable to Bridges context

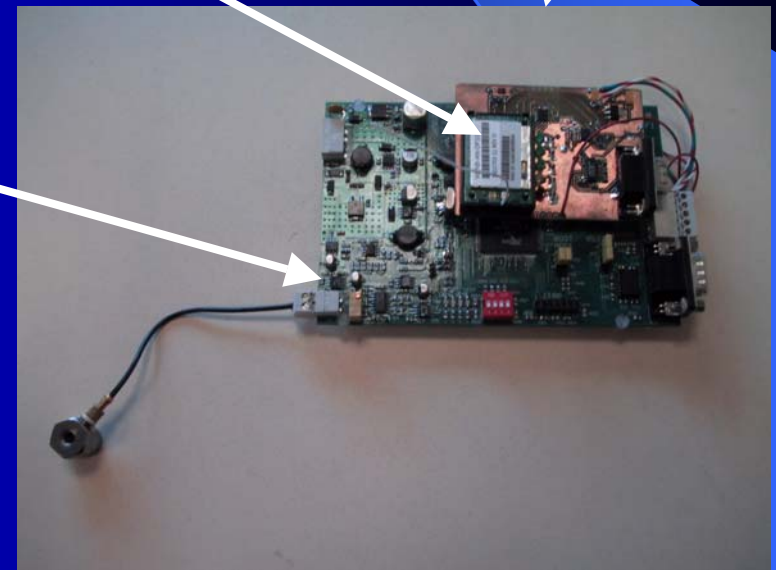


A simple access point connected to a traditional PC provides a wireless TCP/IP area.

LCPC Wireless platform description

LCPC smart sensor:

- Sensor core is a DSP : dedicated to signal processing (FFT, filtering...). Hosts an OS
- DSP embedd the real-time μ Linux OS. Permanently runs the **application** algorithms
- A TCP/IP – Wifi module for wireless communications
- A 12 bits converter that runs data digitalization up to 1 Mhz. Sensitive element : piezzo, strain-gauges, T°c...
- A GPS module for sensor absolute time synchronization



LCPC Wireless platform description

Supervisor :

- An Oriented Object developed software : easily able of customization from one **application** to another. Reusable software bricks.
- Runs on any standard PC : that all include a native TCP/IP stack = communication with sensors is **fully transparent**
- Offers intuitive interfaces to **manage and configure the sensor network** :
 - To add/remove sensors object in the monitoring system
 - To change a sensor parameter,
 - To dis/enable a sensor in the network,



LCPC Wireless platform description

LCPC platform main contributions :

Abstraction : TCP/IP protocole makes the supervisor-sensors system independent of the physical link (wired or wireless) and of the distance (from meters to 1 km)

Transparent communications : applications hosted by the platform fully profit from the abstraction level of the network protocole.

Important : Thanks to the embedded OS and the TCP/IP protocole, running softwares can be upgraded without uninstalling the sensor of the structure.

Generic : Platform could host different types of sensitive elements : piezzo-electric, anemometer, strain gauges, etc.

High time synchronisation (1 μ s) thanks to GPS module



Application : cable crack monitoring

Goals of the system :

Safety, Structure durability, Cost efficiency

Knowing the number of wire breaks and their location in cables contributes to understand the well-being of the structure

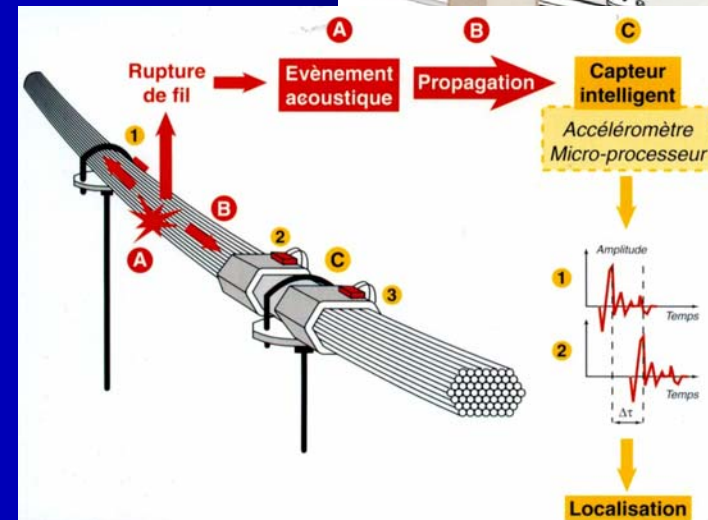
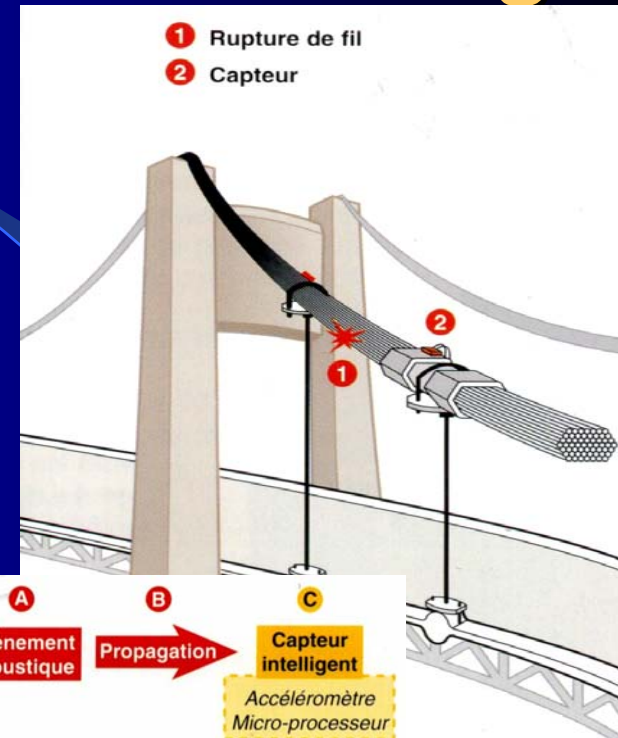
To provide a health monitoring of cables by an acoustic surveillance.



Application : cable crack monitoring

Principle of detection by sensors :

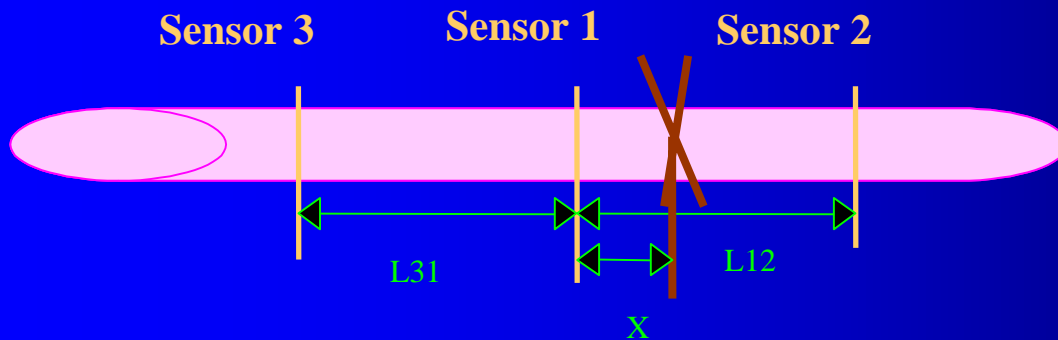
- When a wire breaks, an acoustic wave is generated,
- Wave is detected by sensors, recorded (during 8ms) and very precisely dated,
- Then, sensors transmit those informations to a remote supervisor
- By 3 acoustic sensors informations, supervisor is able to evaluate when and where a rupture occurred



Application : cable crack monitoring

Principle of localization by supervisor :

- Wave speed “S” is estimated by informations from sensor 1 and 3,
- Localization “X” is evaluated between sensor 1 and 2



$$S = L31 / \Delta t31$$

$$X = \frac{1}{2} * (L12 - S * \Delta t12)$$

Application : cable crack monitoring

- Sensors are 10m equispaced,
- Threshold is about 0.8g,
- Speed wave is about 5000 m/s



Contrôle en temps réel
de la sécurité
des ponts suspendus

Tancarville Bridge



Iseron Bridge

**Result : an accuracy of +/-15cm
in wire breaks evaluation.**

Application : cable crack monitoring

Instrumentation of Merlebach Bridge by the wire and the wireless version of the SHM platform.

Sensor distribution



Wireless version

Wire version



Application : cable crack monitoring

Signal acquisition

