

LUCID DREAMING

RELIABLE ANALOG EVENT DETECTION
FOR ENERGY-CONSTRAINED APPLICATIONS

WHAT IS AUTONOMOUS CRACK MONITORING?

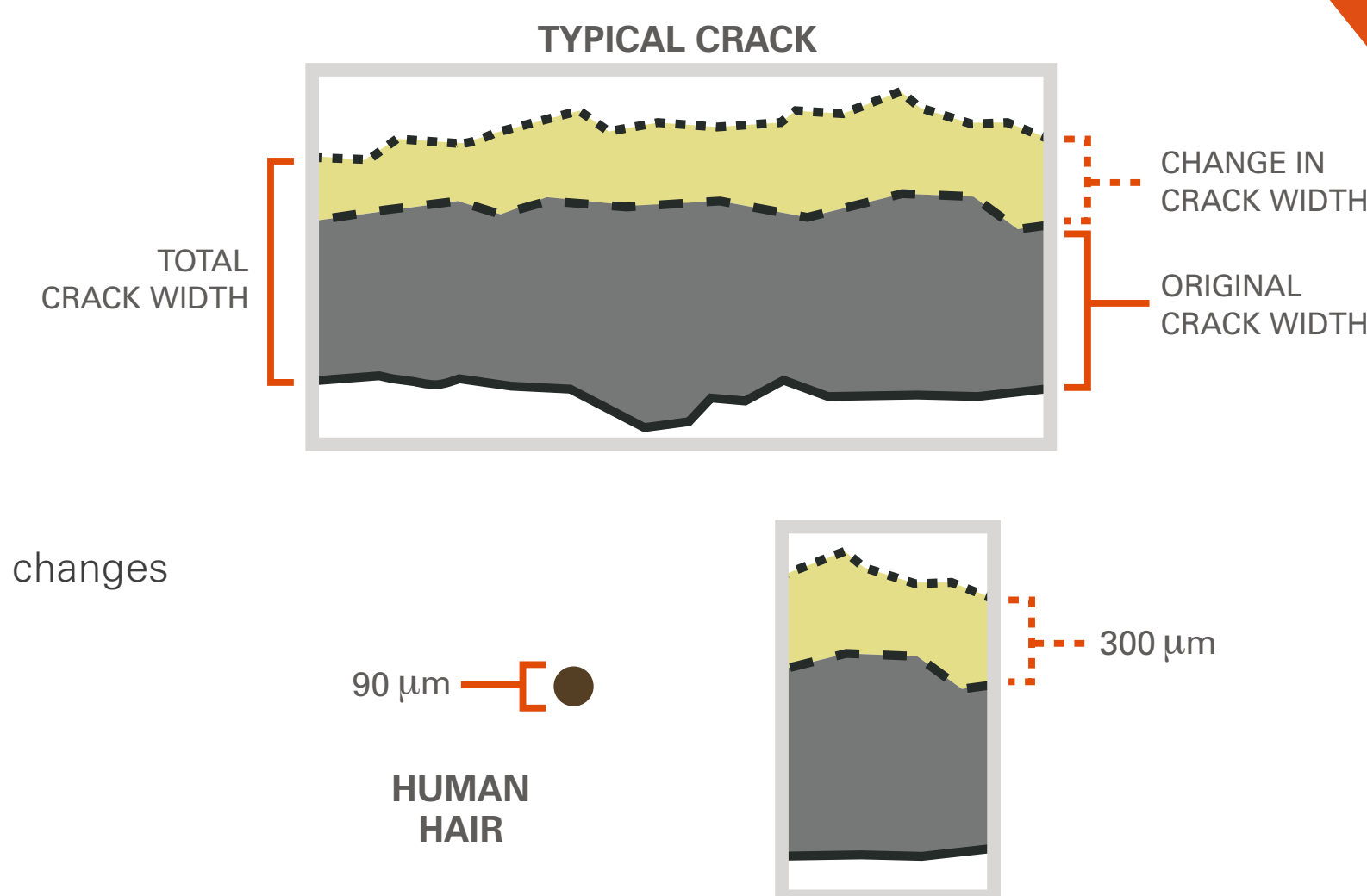
WHY MEASURE CRACKS?

ACM automatically records crack displacements caused by nearby blasting or construction and compares them to:

Causes of Crack Displacement in a Typical Wall:

- Differential thermal expansion
- Structural overloading
- Chemical changes in mortar, bricks, plaster, and stucco
- Shrinkage and swelling of wood with temperature and humidity changes
- Fatigue and ageing of wall coverings
- Differential foundation settlement

The largest crack movement during a heating session is 300 μm , which is just over 3 times the size of a human hair (90 μm).



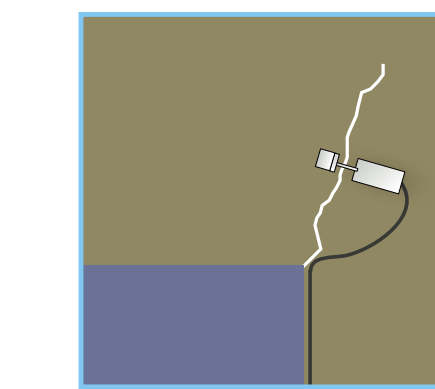
LOTS OF CRACKS MEANS LOTS OF WIRES WHICH MEANS LOTS OF TIME AND EFFORT.

Many sensors are installed throughout a structure and wired to a single data logger.

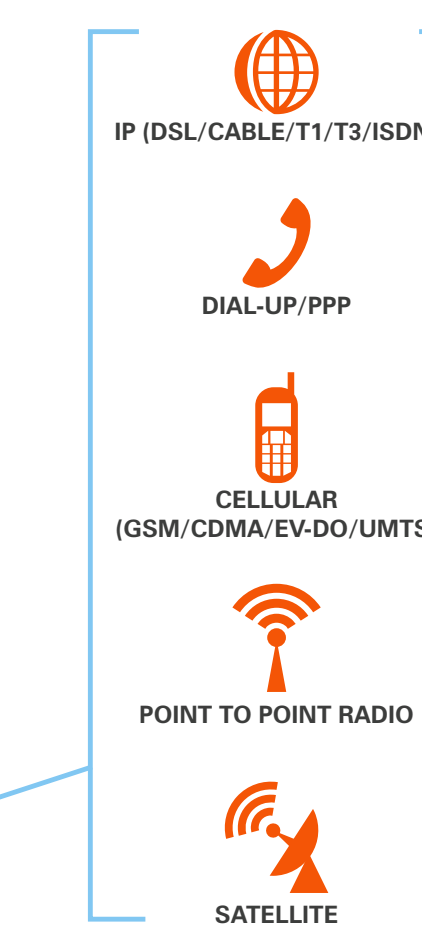
Air waves are recorded by a microphone which is installed on the outside of the house and wired to the data logger.

Nearby construction activity or mining operations create ground motion and airwaves (which may or may not be audible).

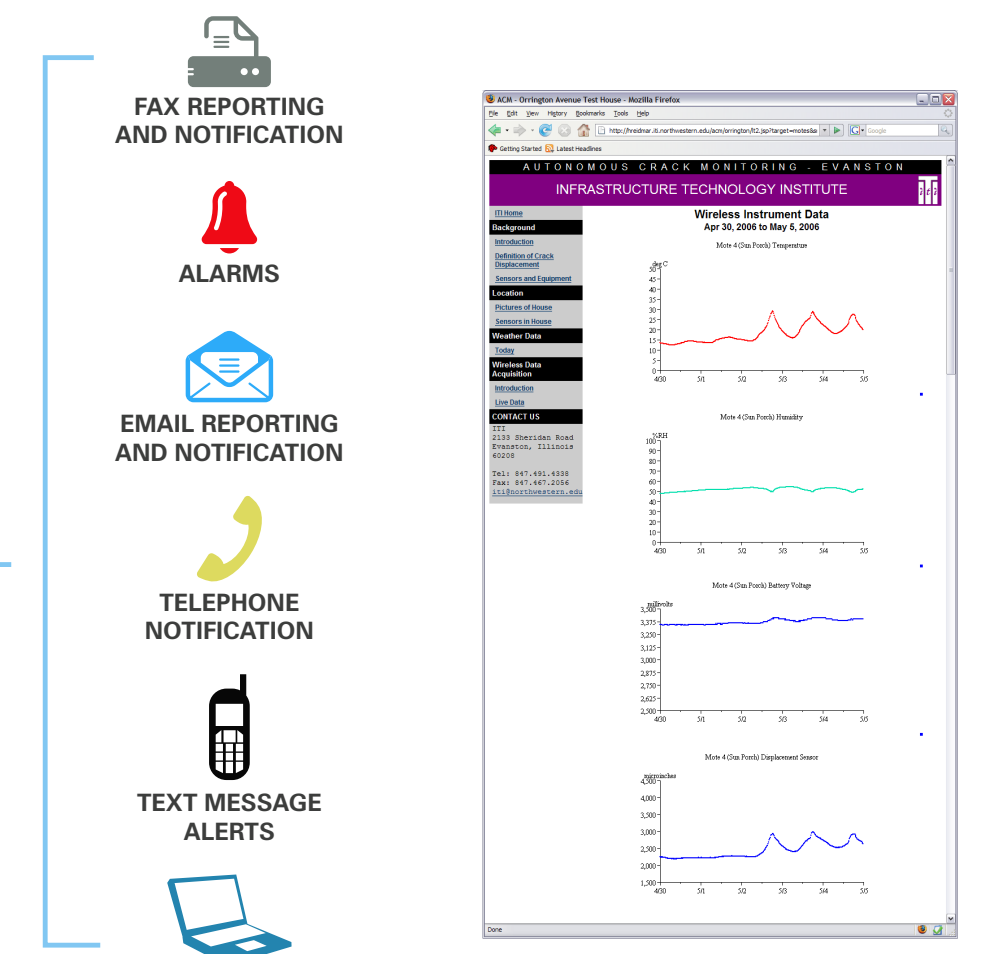
Ground motion is recorded by a geophone that is buried underground and wired to the data logger.



Displacement gauges with micrometer resolution are glued to walls spanning cracks of interest throughout the structure.



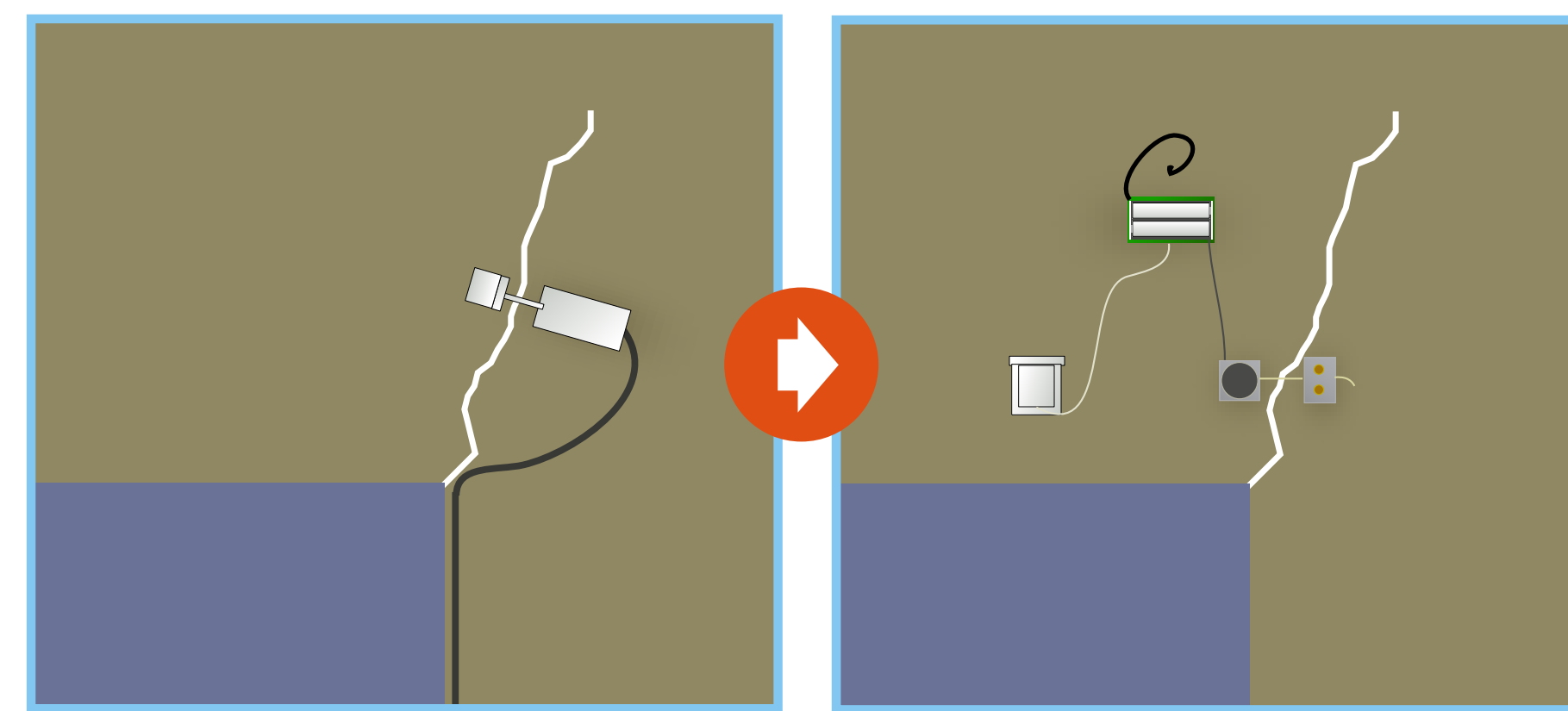
The data is automatically sent to the server via one of many communication mechanisms where it is processed and archived for display graphically over the world wide web.



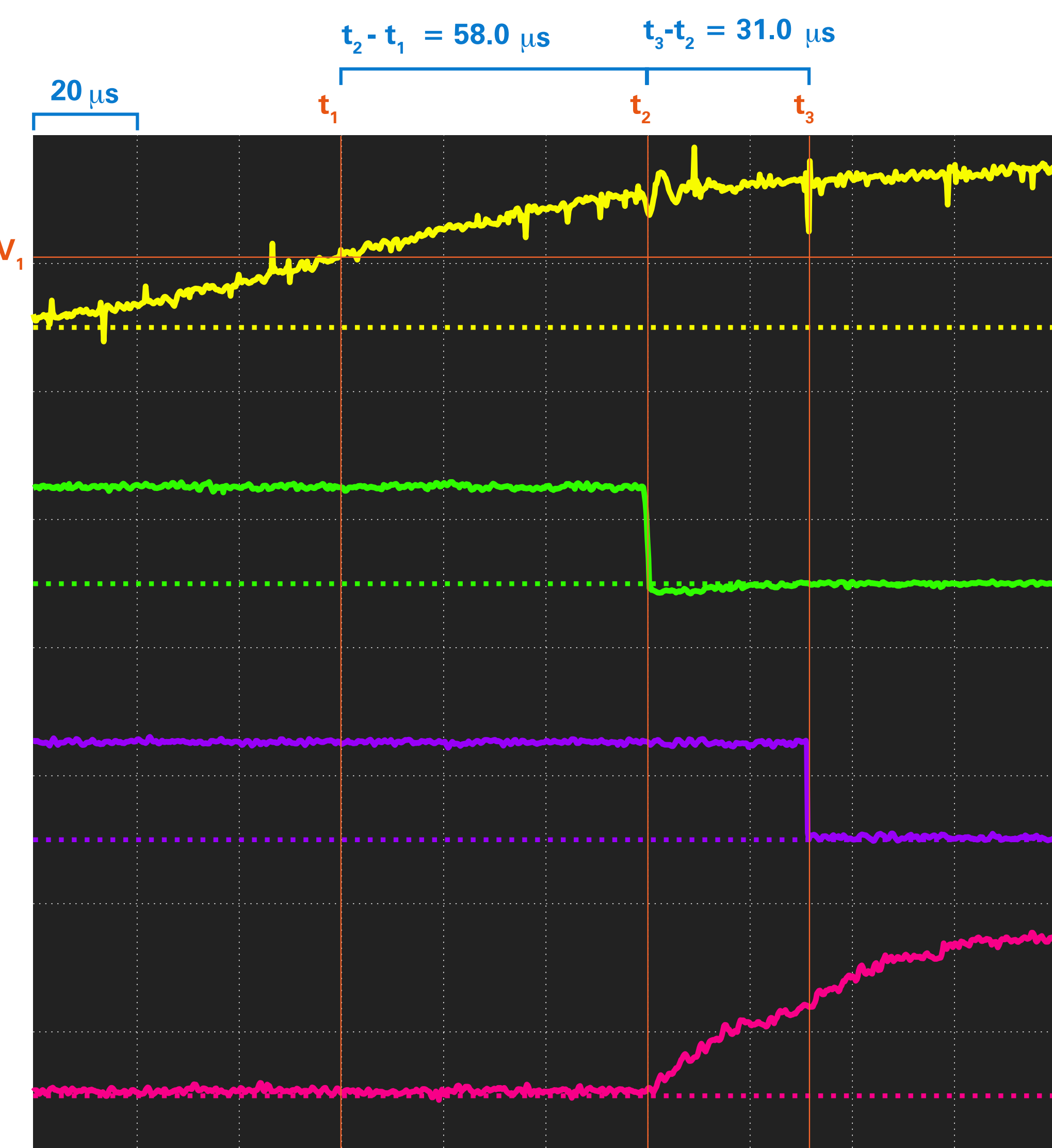
The data can now be used globally.

HOW DO WE...

- ELIMINATE THE WIRES? USE A WIRELESS SENSOR NETWORK.
- CONSERVE POWER? SLEEP MOST OF TIME.
- WAKE UP TO RECORD **ALL RANDOMLY OCCURRING** VIBRATION EVENTS? ENTER SHAKE N' WAKE ...

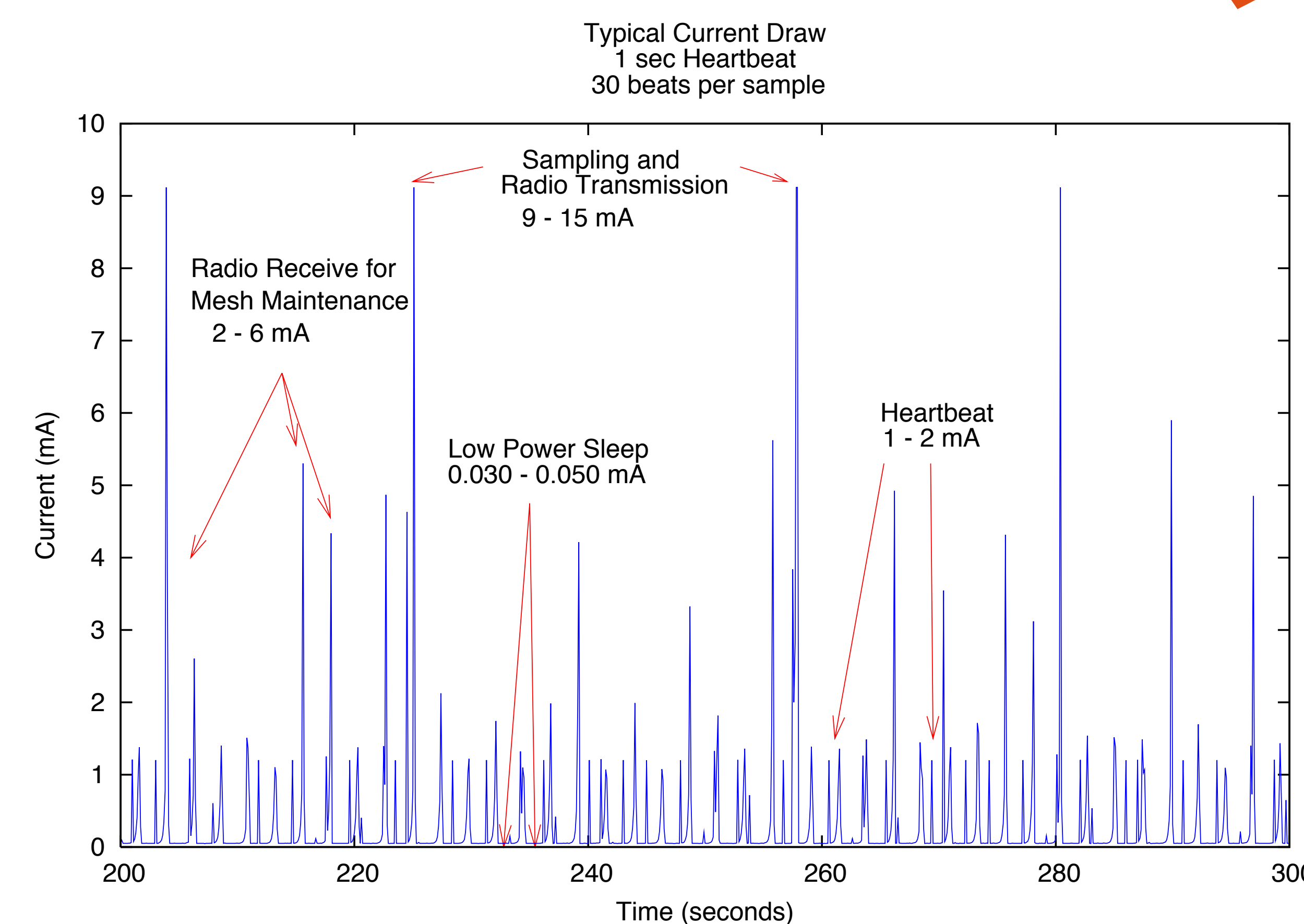
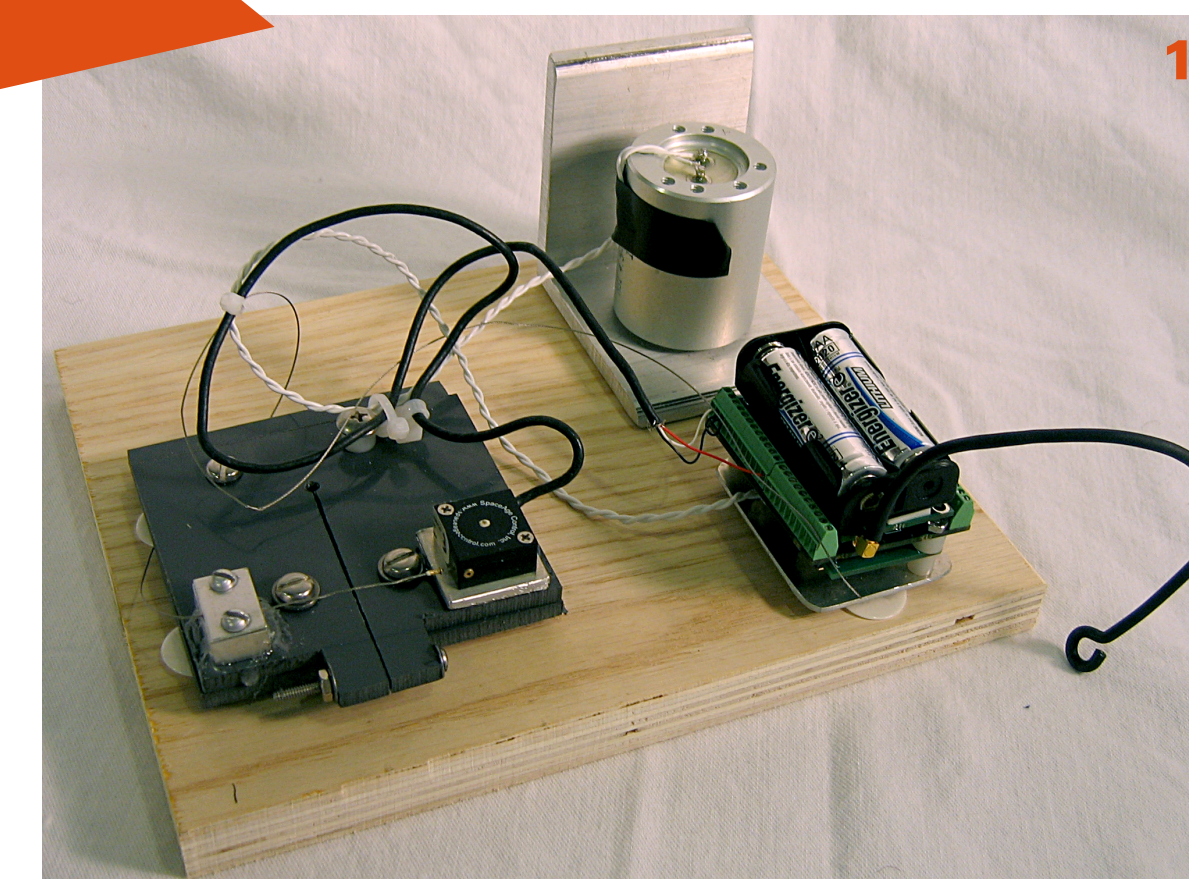


NO WIRES running from crack to base station.



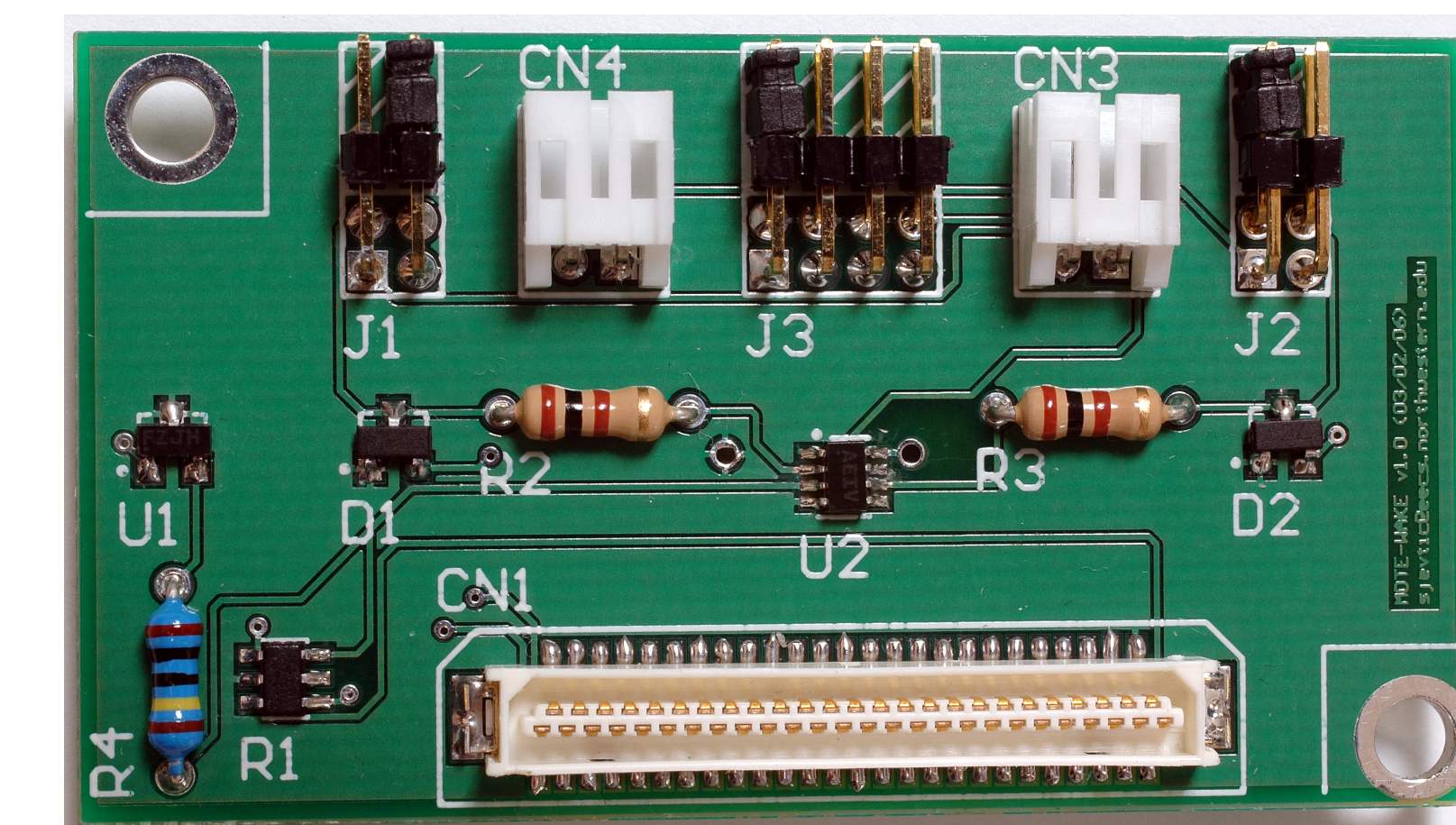
User code is executed 89 μs after the trigger threshold occurs.

1. Wireless ACM with Shake 'n Wake mounted on a crack simulation platform.
2. Base station with data logger and cellular connection.
3. Wireless ACM system installed in a home.

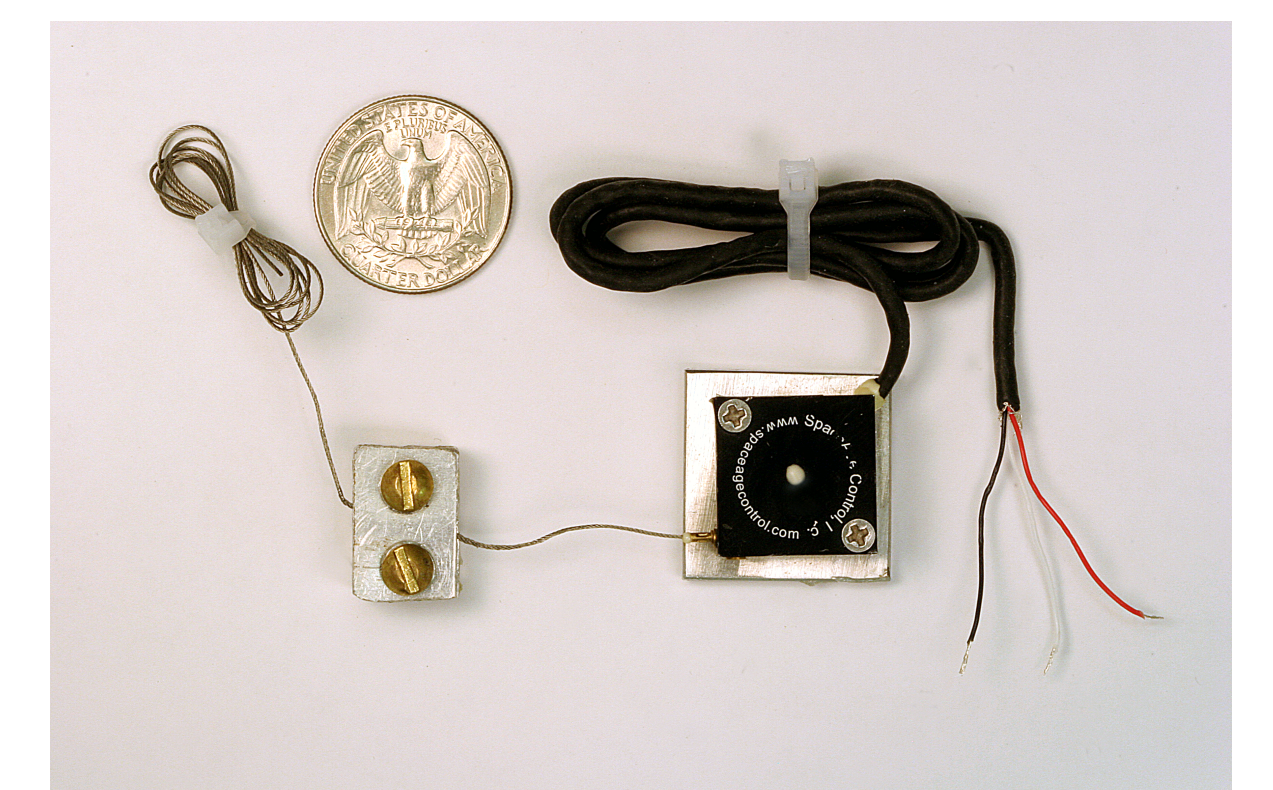


Heartbeat interval and beats per sample are both adjustable in real-time so sleeping time can be maximized.

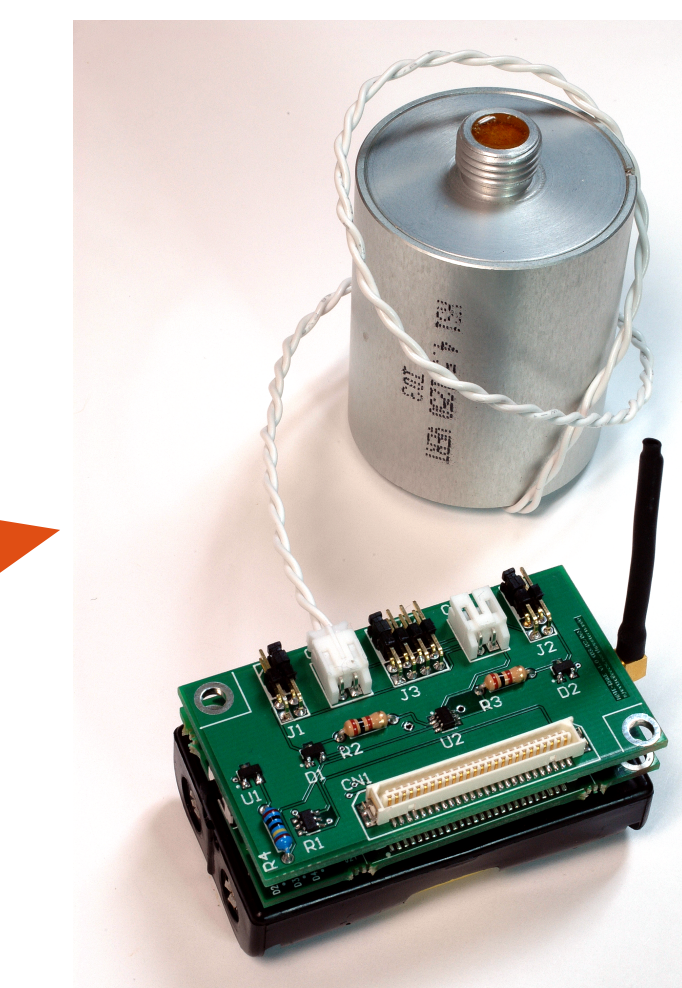
HOW IS IT BUILT?



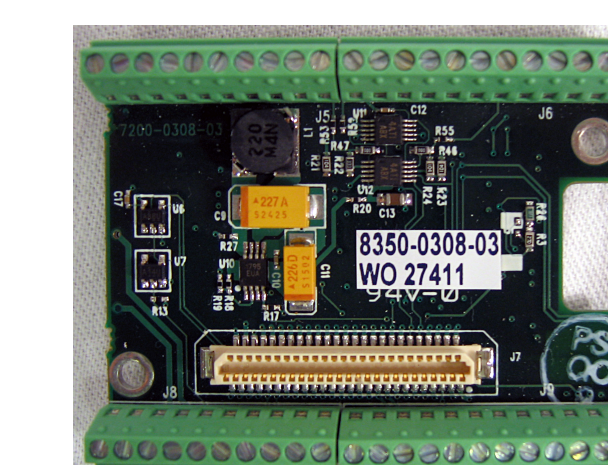
Shake n' Wake PCB



Ratiometric String Potentiometer Displacement Transducer

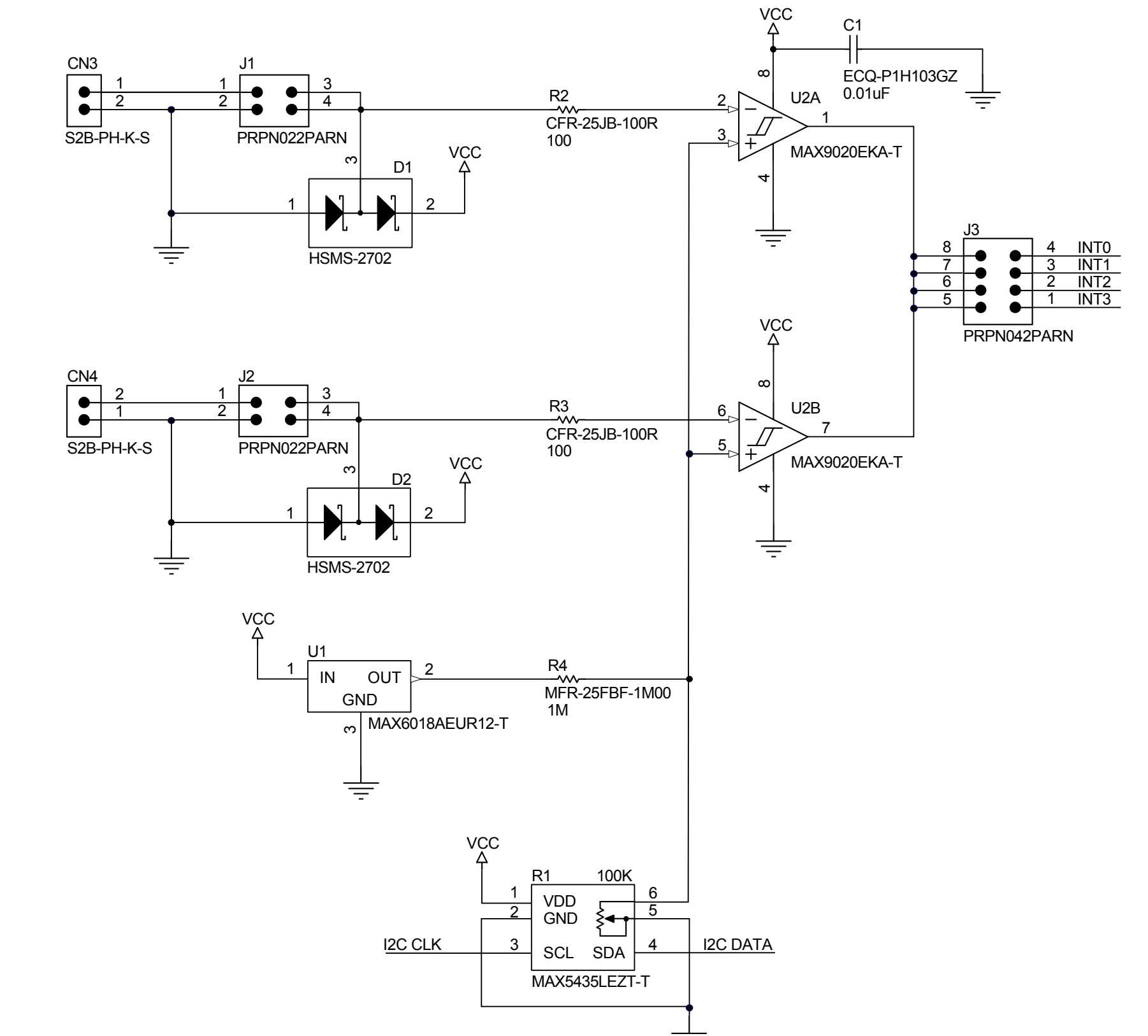


MicaZ mote with Shake n' Wake and Geophone



Crossbow MDA300 General Purpose Data Acquisition Board

Shake n' Wake Circuit



NORTHWESTERN
UNIVERSITY

Sasha Jevtic:
Mat Kotowsky:
Dr. Robert Dick:
Dr. Peter Dinda:
Dr. Charles Dowding:

sjevtic@eecs.northwestern.edu
kotowsky@northwestern.edu
dickrp@northwestern.edu
pdinda@northwestern.edu
c-dowding@northwestern.edu

Graphic Design by
Melissa Mattenson:

mattenson@northwestern.edu