Self Sustaining CPS for Structural Monitoring

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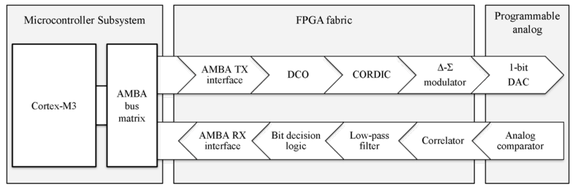
LOW-POWER WIRELESS PLATFORM

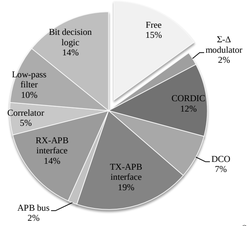
- WSN research is **severely limited** by COTS (**black box**) **radios**
- **Software Defined Radios** (SDR) would enable new research directions
- **Power consumption is prohibitive** with SRAM FPGA-s
  - Significant **static power** (configuration)
  - Inefficient **duty cycling** (startup)

Marmote: Flash FPGA WSN platform

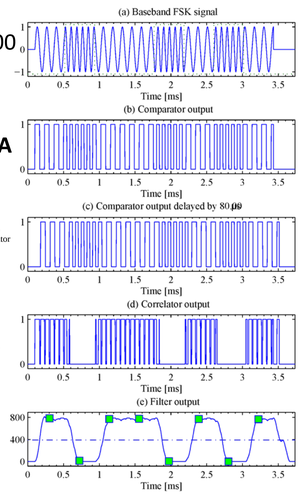
EXAMPLE: FSK TRANSCEIVER



- Comparable to TI CC1000
- 433 MHz carrier
- 10k baud rate
- **(De)Modulation in FPGA**

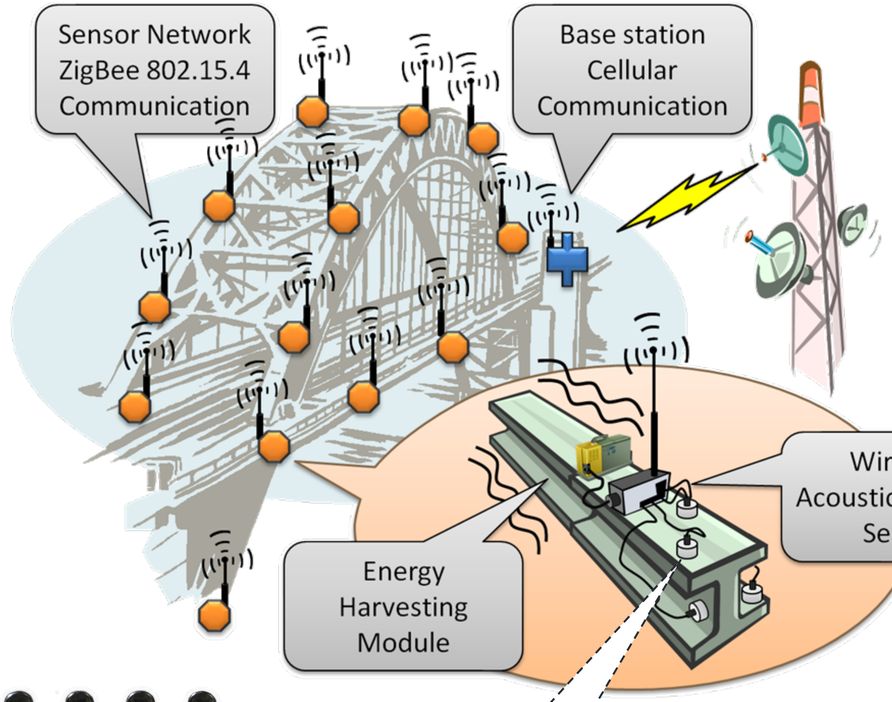


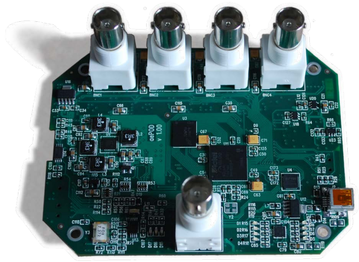
Resource Utilization

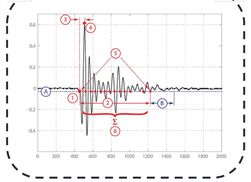


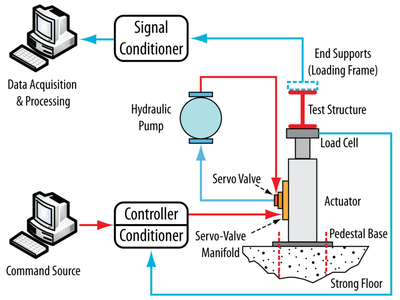
STRUCTURAL HEALTH MONITORING

Self sustaining, autonomous, **wireless** structural monitoring system based on a rich set of sensor modalities detecting **vibration** (accelerometers), **stress** (strain gauges) and **cracks** (AE sensors) supported by a novel vibration-based **energy harvester self-tuned** to a broad range of excitation frequencies.





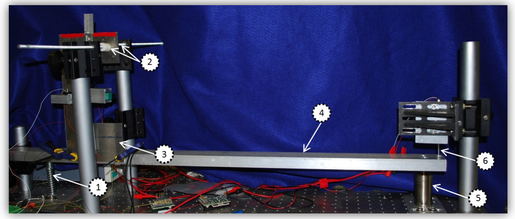




Early prototype – Flash FPGA-based Acoustic Emission Sensor Node (AEPod)

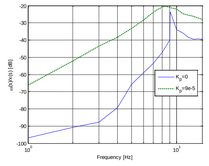
Laboratory Experiment Setup

VIBRATION-BASED ENERGY HARVESTER

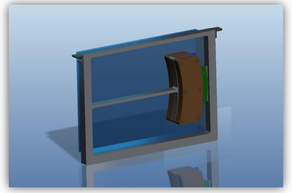


1. Counterbalance spring
2. Hard stops
3. Harvester mounting plate
4. Beam used for base motion (bridge motion)
5. Linear voice coil actuator for base excitation
6. Linear potentiometer (measurement)

Frequency response of the harvester to base (bridge) motion. Shows a broadening of the resonant peak through controlled motoring and generation.



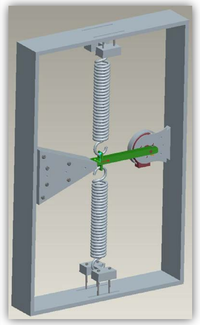
HARVESTER PROTOTYPE #1



- Beam-Spring Design zero sliding friction
- No bearing surfaces
- No brushes

Utilizes **Linear Arc** (Larc Motor) for generation and control

HARVESTER PROTOTYPE #2



Servo-disk motor

- High torque, low speed
- Moving mass (10kg)
- Integrated pot and tach

- Modern highway bridges: 2-5 Hz
- Very stiff bridges: 10-15 Hz

- Modular design