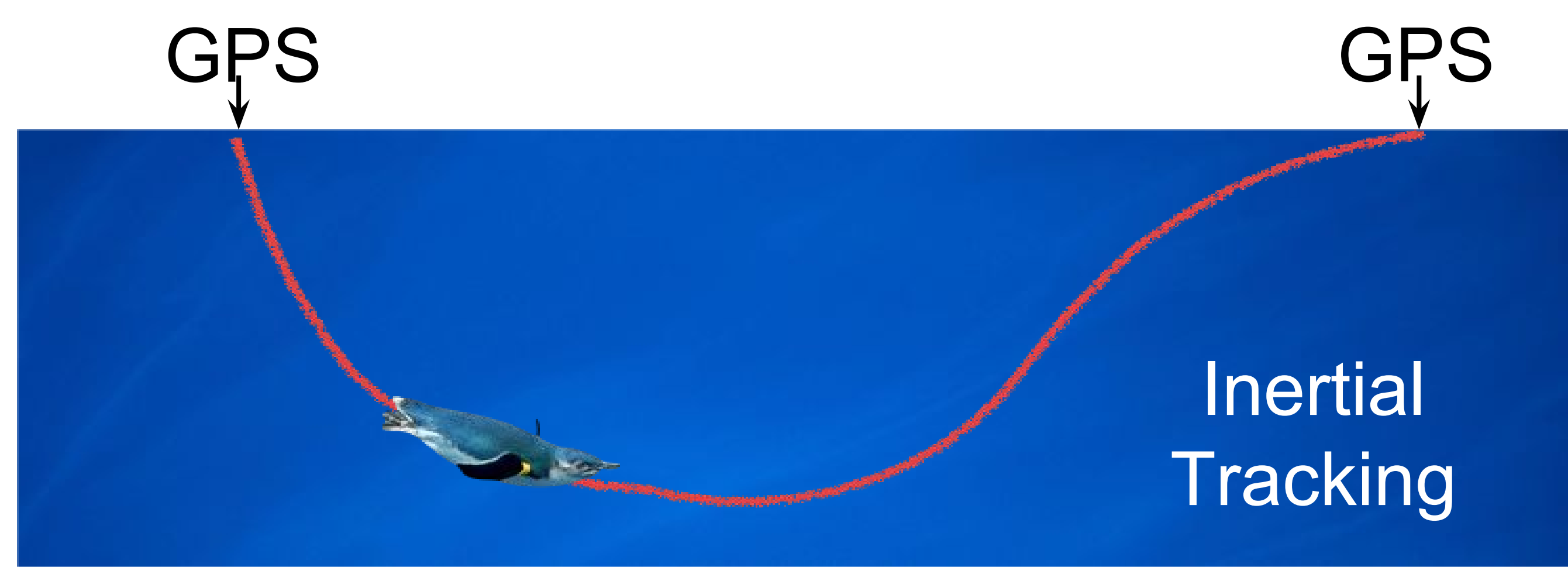


AquaMote: Ultra Low Power Sensor Tag for Animal Localization and Fine Motion Tracking

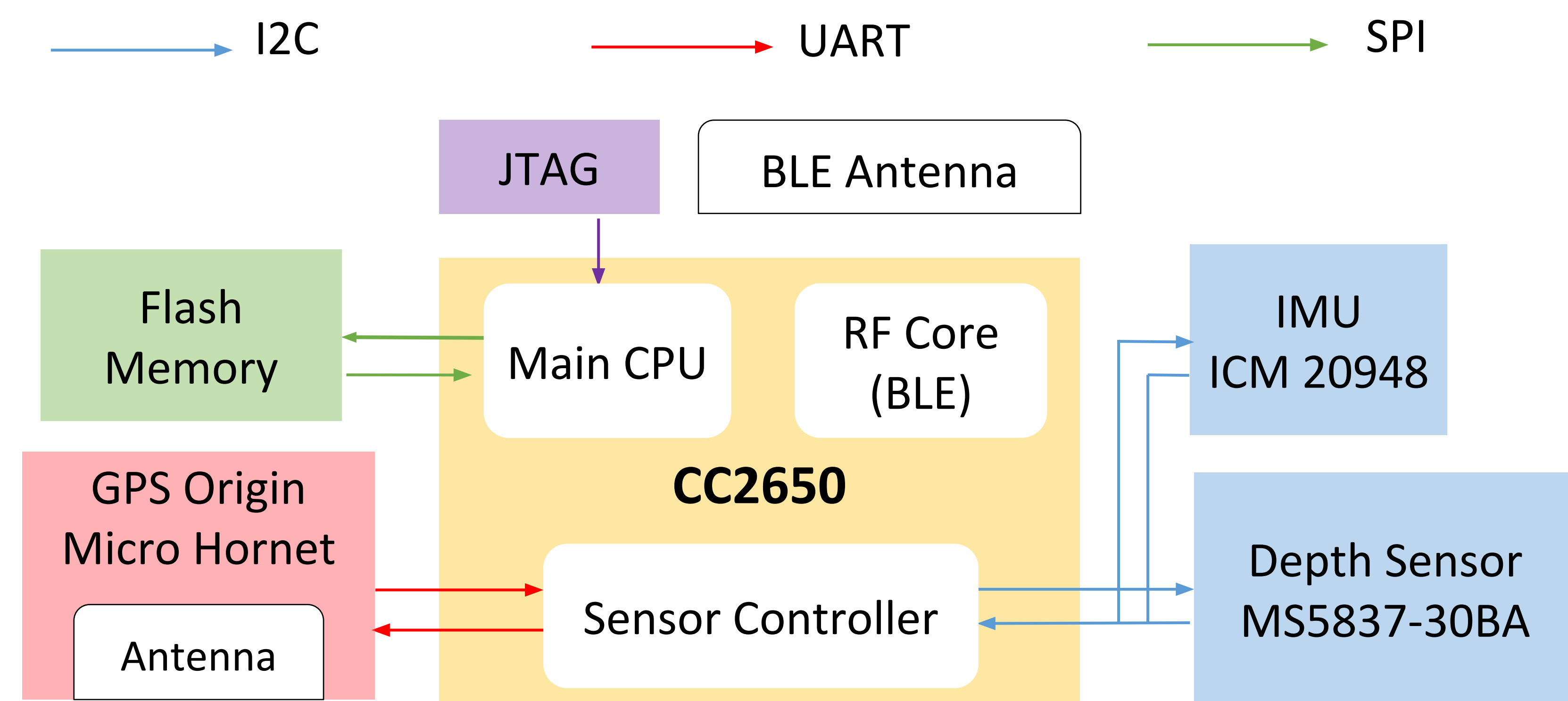
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University of California, Los Angeles

Localization to Track Animal Behavior



- Sensor tags reveal nuanced animal behavior and ecosystem dynamics
- Localization is key to understanding animal context
- Design objectives:
 - Provide frequent, accurate and fine-grained location
 - Have a long life and be extremely small

Design Architecture



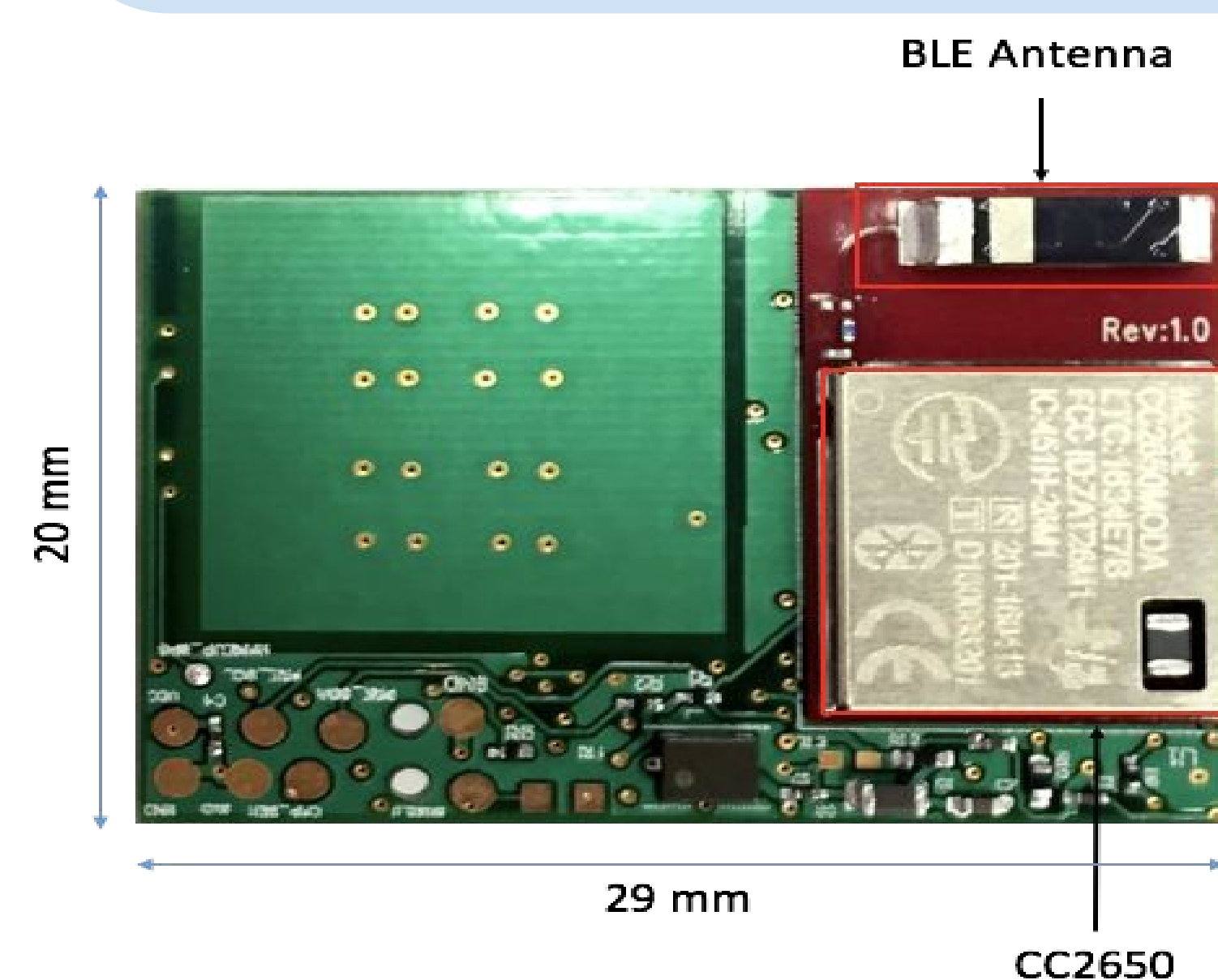
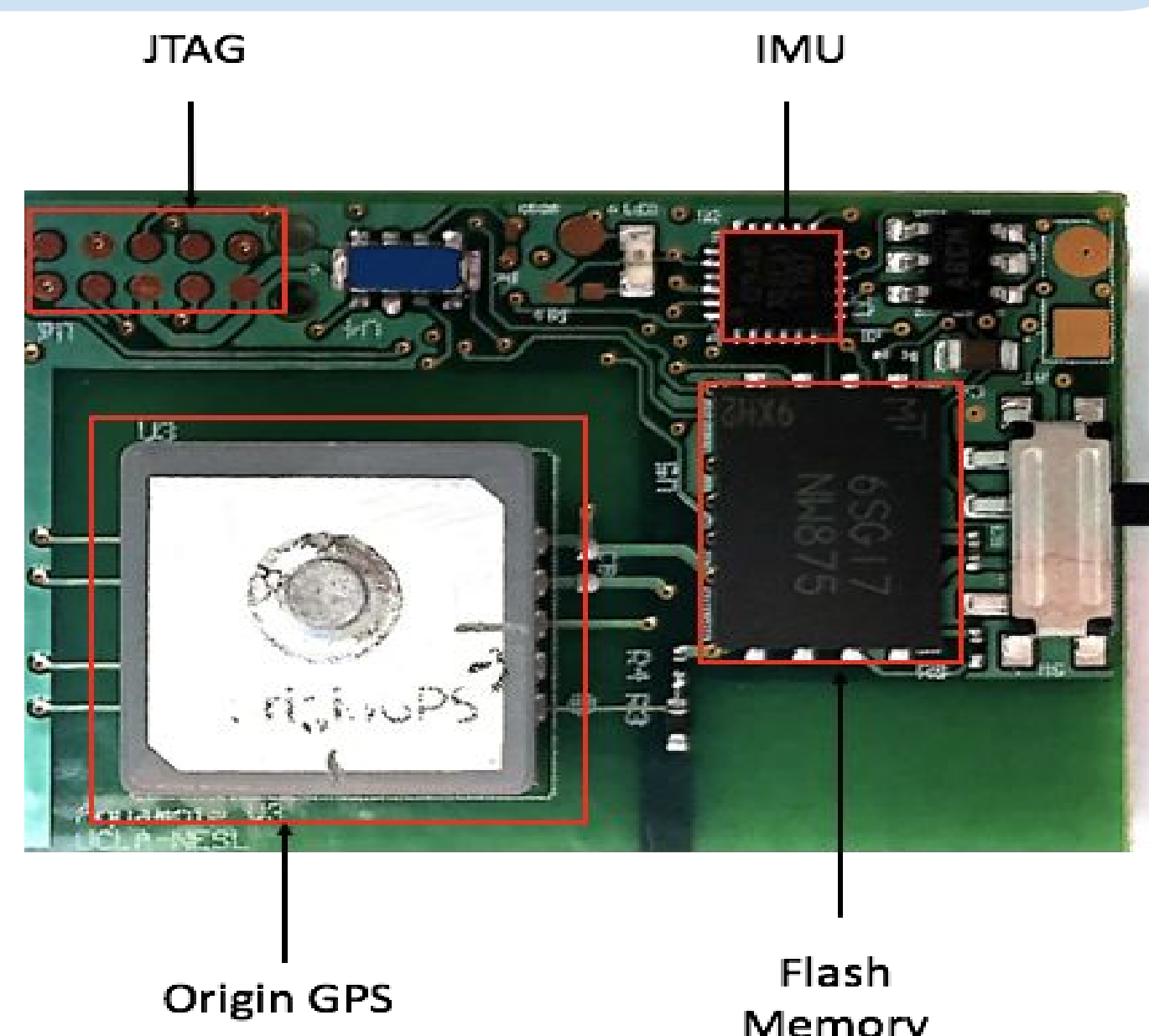
AquaMote Tag

Inertial Measurement Unit

- IMU data gives information on the actions and behaviour of the animals.
- Timestamped by using the real time clock of the Microprocessor.
- Time is synchronized opportunistically with the absolute time from GPS.

GPS

- Time to First Fix is reduced to less than 6 seconds by storing valid Satellite Ephemeris and Almanac data in the GPS RAM.
- GPS is turned on only when the animal surfaces based on the reading from the pressure sensor which helps in saving power.



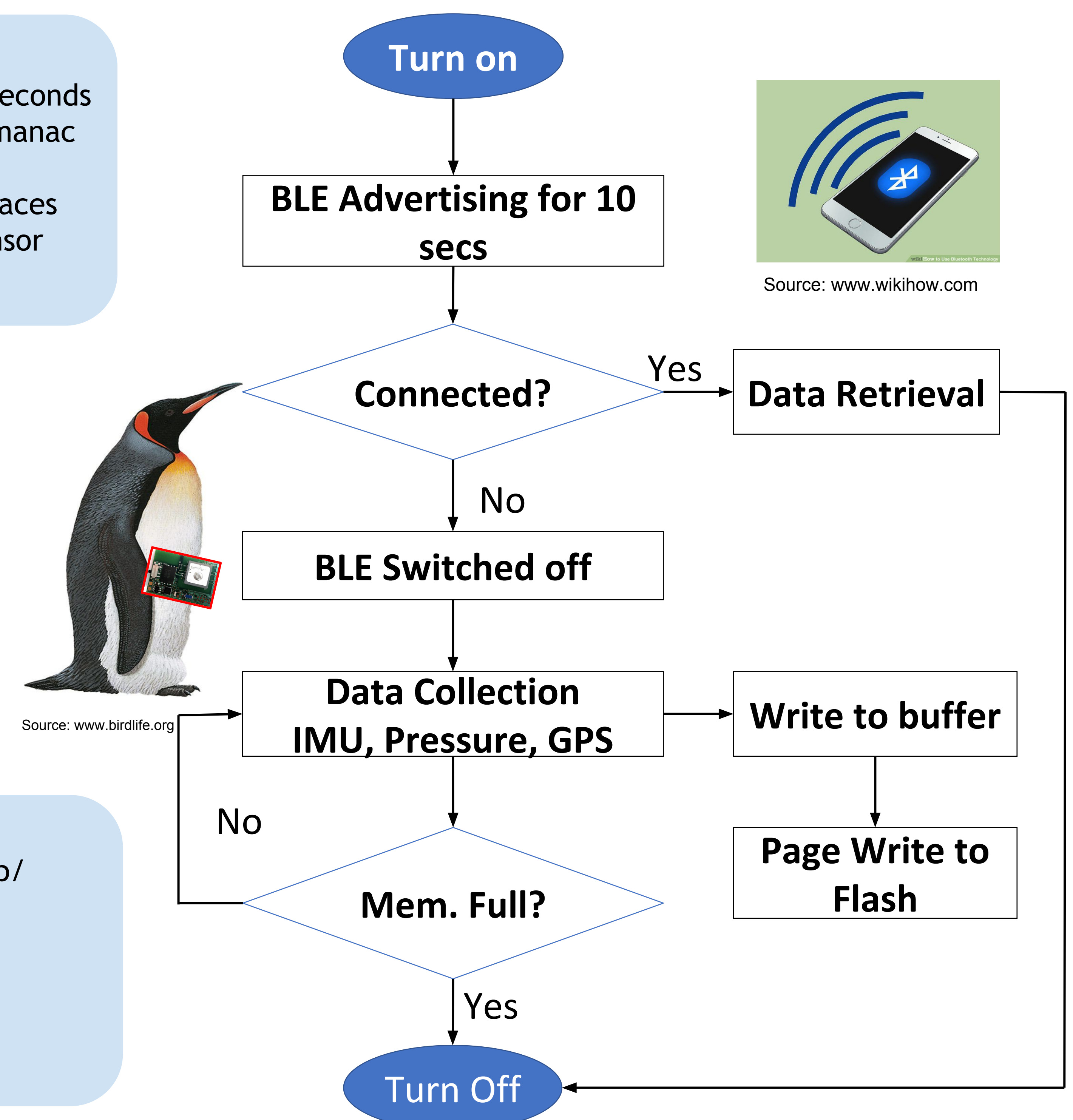
Flash Memory - NAND Flash

- Preferred over an SD card because it's much smaller physically.
- Has much smaller read/write current.
- At the given voltage level, NAND Flash has limited storage capacity.
- Sensor rates might be reduced to allow more lifetime in the field.

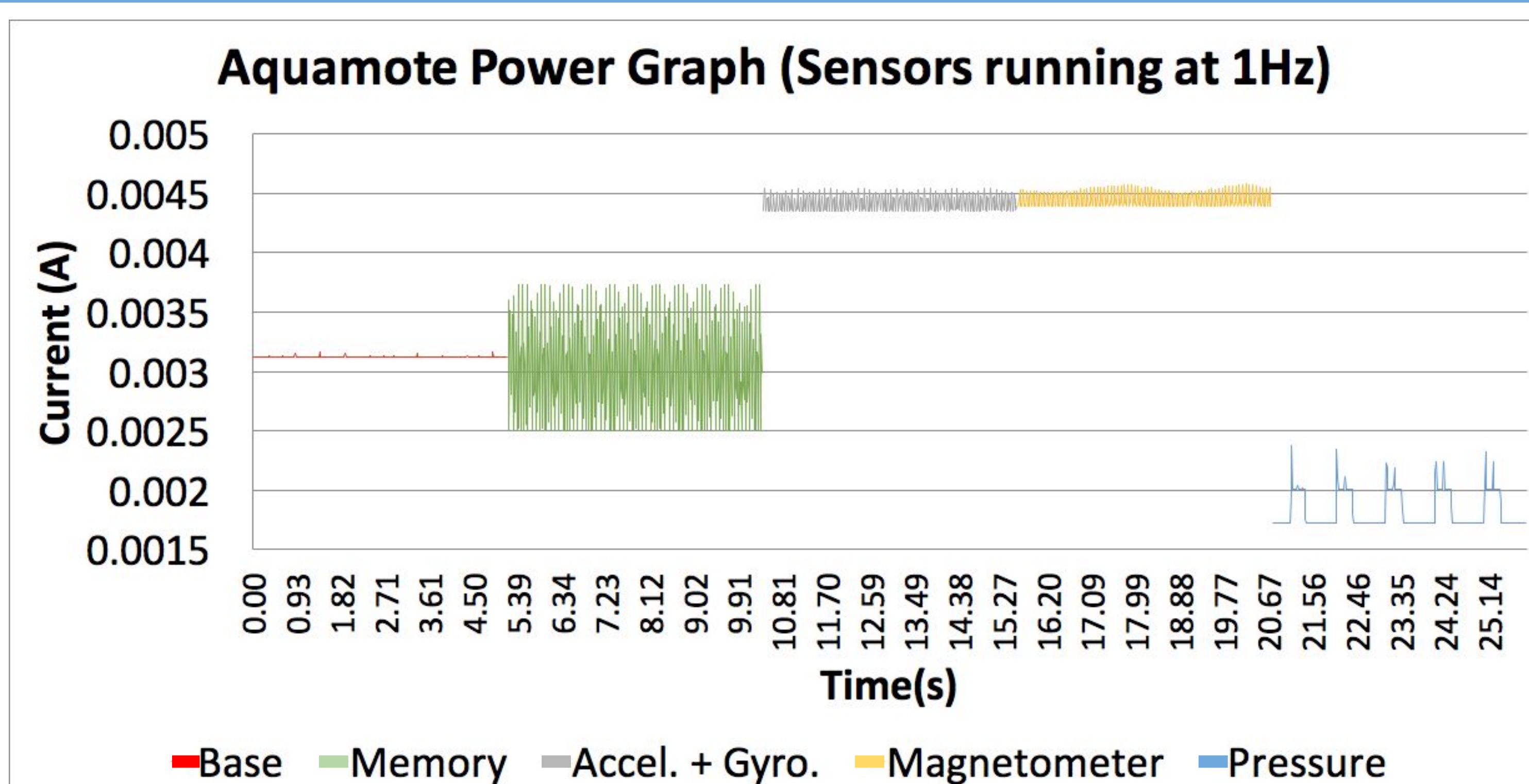
Bluetooth Low Energy

- Facilitates data retrieval to a host (Laptop/ Smartphone).
- Allows erasing the data and tweaking calibration parameters.
- Permits communication between known anchors and other sensor tags.

Software Work Flow



Power Analysis



- Measured using Keithley source meter with accuracy of 0.6 uA
- Board supply voltage: 1.8V

Future Work

- Localization is difficult as accelerometer, gyroscope, and magnetometer are noisy.
- Better accuracy can be achieved with higher data collection frequency.
 - Using virtual gyroscope mitigates use of power hungry gyroscopes. With 20% sampling, rest of the values can be estimated using neural networks.
 - GPS can provide accurate location, time, and ground truth.

REFERENCES

- [1] [n. d.]. Mitaki Tracking Behaviour in the wild. ([n. d.]). Retrieved August 16, 2017 from <http://mitaki.org/devices/>
- [2] [n. d.]. NanoFix Products. ([n. d.]). Retrieved August 16, 2017 from <http://www.pathtrack.co.uk/Site/nProducts.html>
- [3] Ruth M Casper. 2009. Guidelines for the instrumentation of wild birds and mammals. *Animal behaviour* 78, 6 (2009), 1477–1483.
- [4] Rory P Wilson, ELC Shepard, and N Liebsch. 2008. Prying into the intimate details of animal lives: use of a daily diary on animals. *Endangered Species Research* 4, 1-2 (2008), 123–137.
- [5] MJ Witt, Susanne Åkesson, AC Broderick, MS Coyne, J Ellick, A Formia, GC Hays, P Luschi, Stedson Stroud, and BJ Godley. 2010. Assessing accuracy and utility of satellite-tracking data using Argos-linked Fastloc-GPS. *Animal Behaviour* 80, 3 (2010), 571–581.