ANIMA Collar Tag Sensor Calibrations & Power Management

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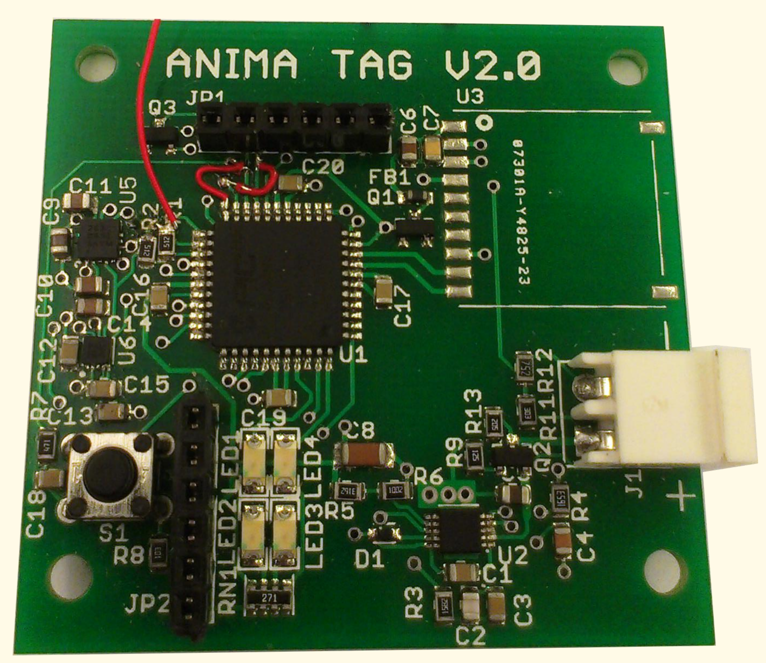
Background and Motivation

Understanding the activity of large mammals is important. The current method of non-invasive study is limited to gathering location information with GPS tracking collars. The ANIMA (Accelerometer Network Integrator for Mobile Animals) project seeks to create **a technologically advanced collar tag that combines GPS information with data from a magnetometer and an accelerometer** to improve understanding of animal behavior and environmental impact.

The information gathered will be used **to reconstruct the behavior, energy expenditure, and movement** of an animal. Tracking collars are necessarily limited in size and weight; thus battery capacity is limited. In order to achieve a long life deployment, **the ANIMA tag must be energy efficient.** A full characterization of the various onboard sensors allows the ANIMA tag to be optimized for both energy usage and performance.

How can we design an animal tracking collar that can collect reliable and comprehensive data while being energy efficient?



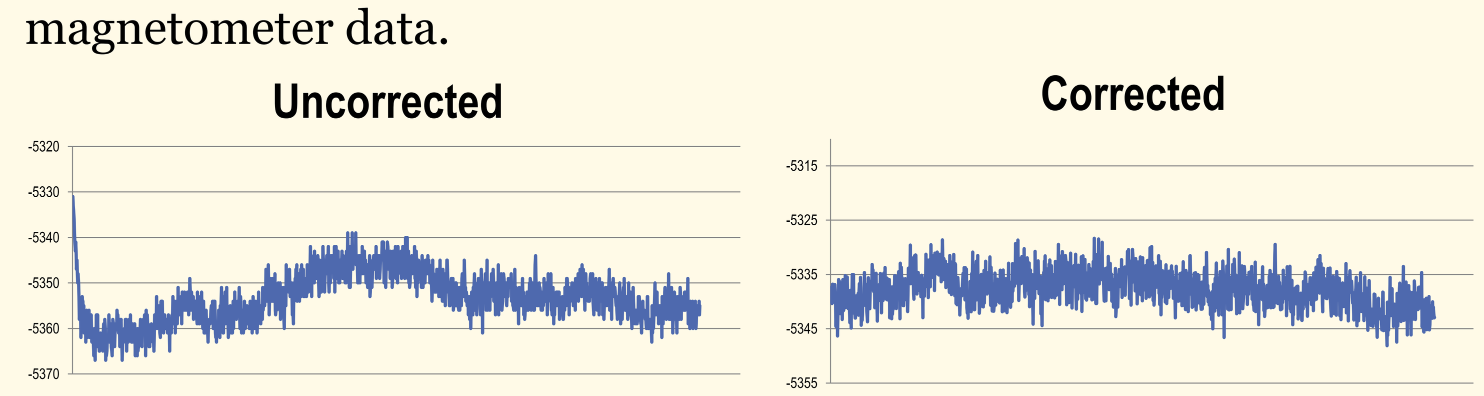
Stability

We **characterized the sensors' noise** using an Allan Variance analysis on data from long duration runs in quiet settings. This characterization quantifies the parameters $\boldsymbol{v_w}$ (wide band noise) and $\boldsymbol{b(t)}$ (bias drift) used in a sensor model: $\boldsymbol{y_m = ky_t + b(t) + v_w}$
This model is used to test algorithms and ensure accuracy.

Temperature Bias

We observed that some of the sensors (especially the magnetometer) drifts with temperature, and implemented a method of characterizing the correlation with a linear regression and corrected the temperature bias.

Figures below show a uncorrected and corrected sample of magnetometer data.

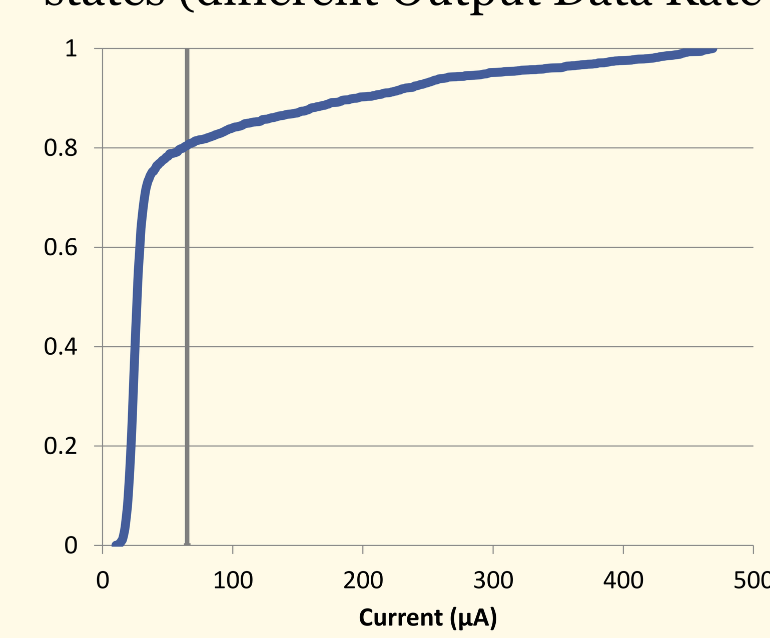


Startup Times

Trials were run on the magnetometer and accelerometer to determine the time from **standby to stability** and from **power off to stability**. The startup times for both sensors depended on their Output Data Rate settings; roughly it took two samples (2/ODR) for the sensors to output reliable data.

Power Requirements

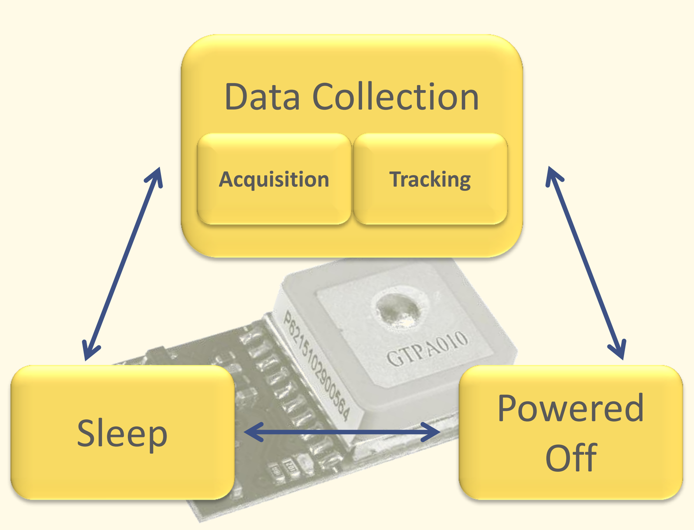
We measured and characterized each sensors' current draw in all states (different Output Data Rate modes, standby, etc).

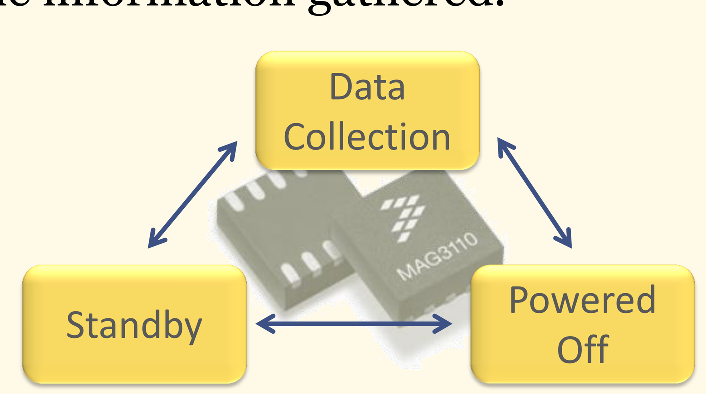


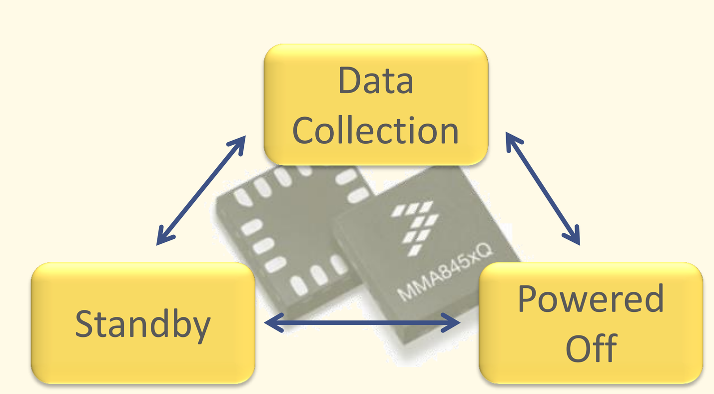
We found that average current draw values generally agreed with the datasheets, but there was a wide distribution that included much higher current draws, as displayed in the example cumulative distribution function to the left.

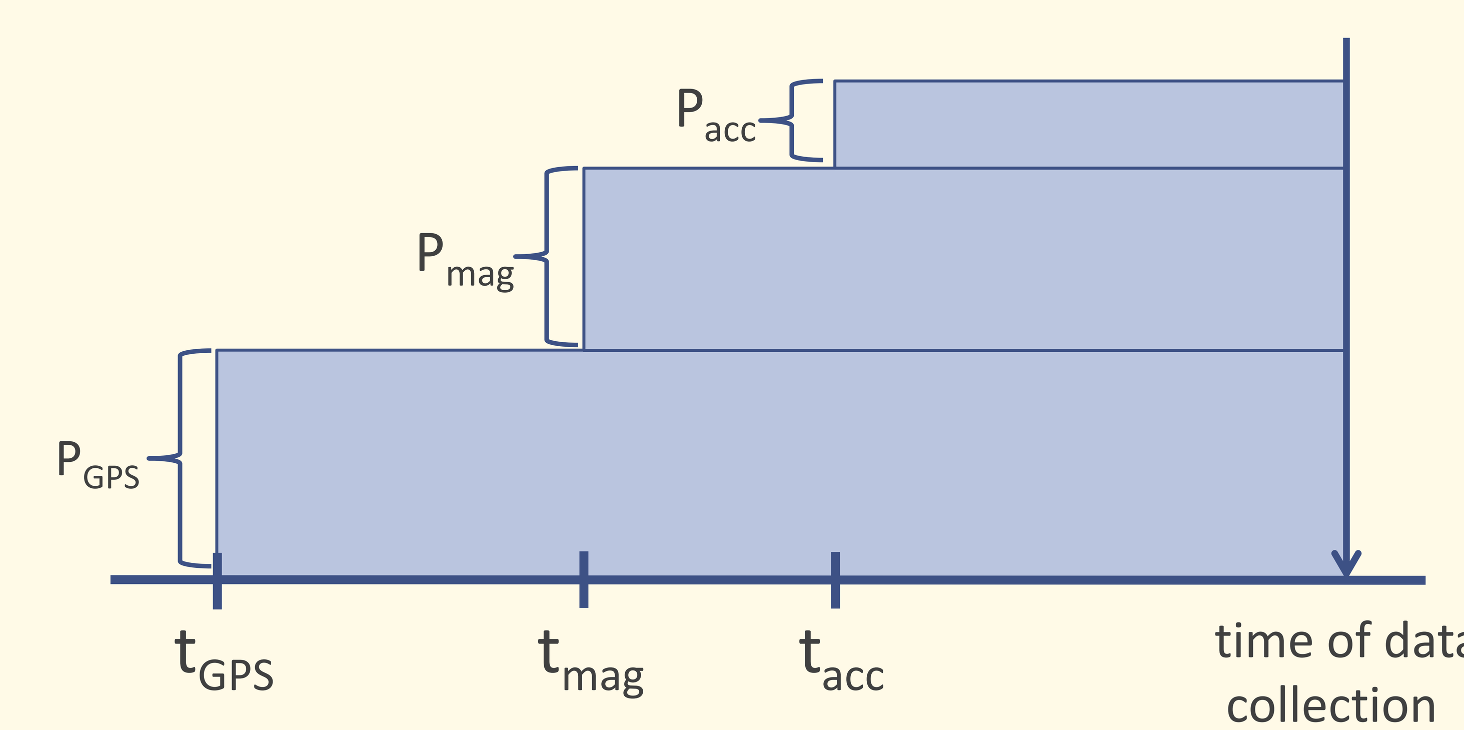
Future Work – Power Aware State Machine

Each of the ANIMA's onboard sensors has **several different modes with different power consumptions** – off, standby or sleep, and data collection. Using information about the startup times of the GPS, accelerometer, and magnetometer in conjunction with information about their current draws, it is possible to sequence power allocation so that the **sensors collect data for the lowest power budget possible**. The next step is to design a state machine that transitions between the sensors' different modes in a power efficient way using the information gathered.









$$\text{Energy Consumption} = P_{GPS} * t_{GPS} + P_{mag} * t_{mag} + P_{acc} * t_{acc}$$