

# Team #1: RAPTR

(Remote Asset and Person Tracking Reporter)

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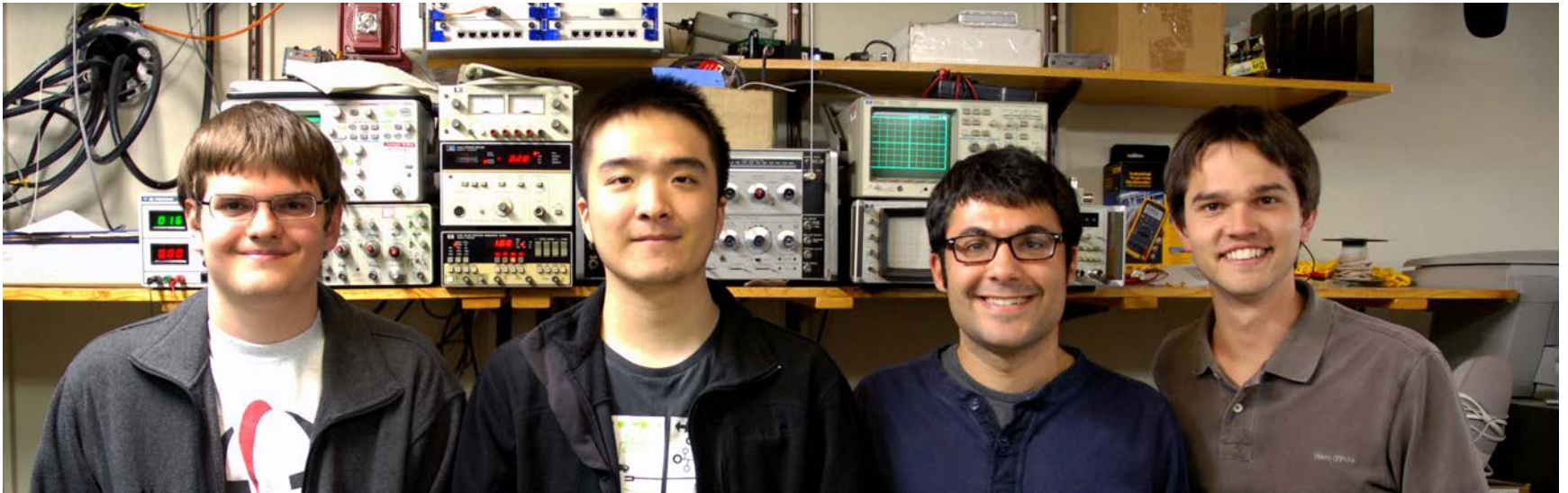
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# Team Members



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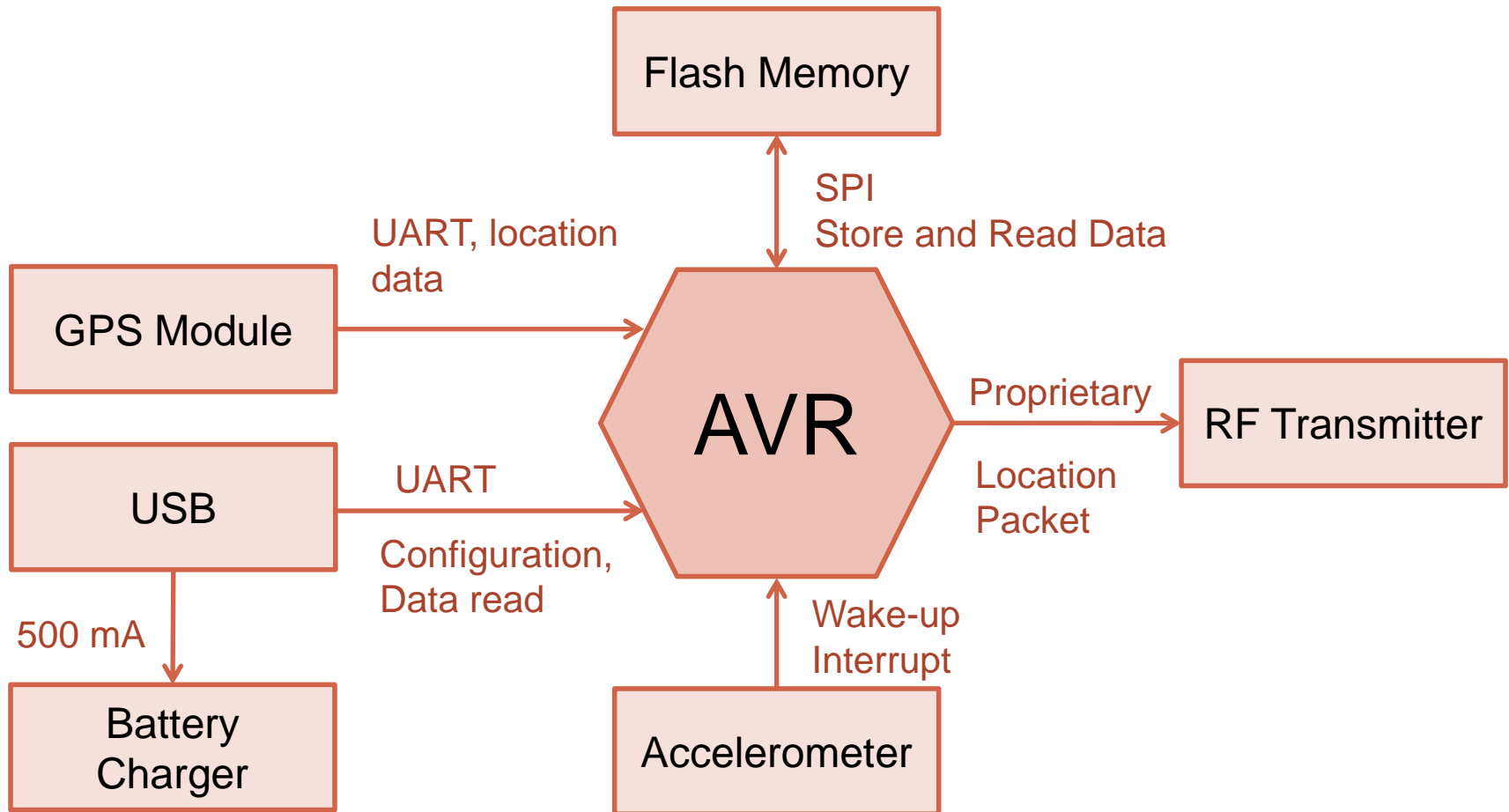
# Concept

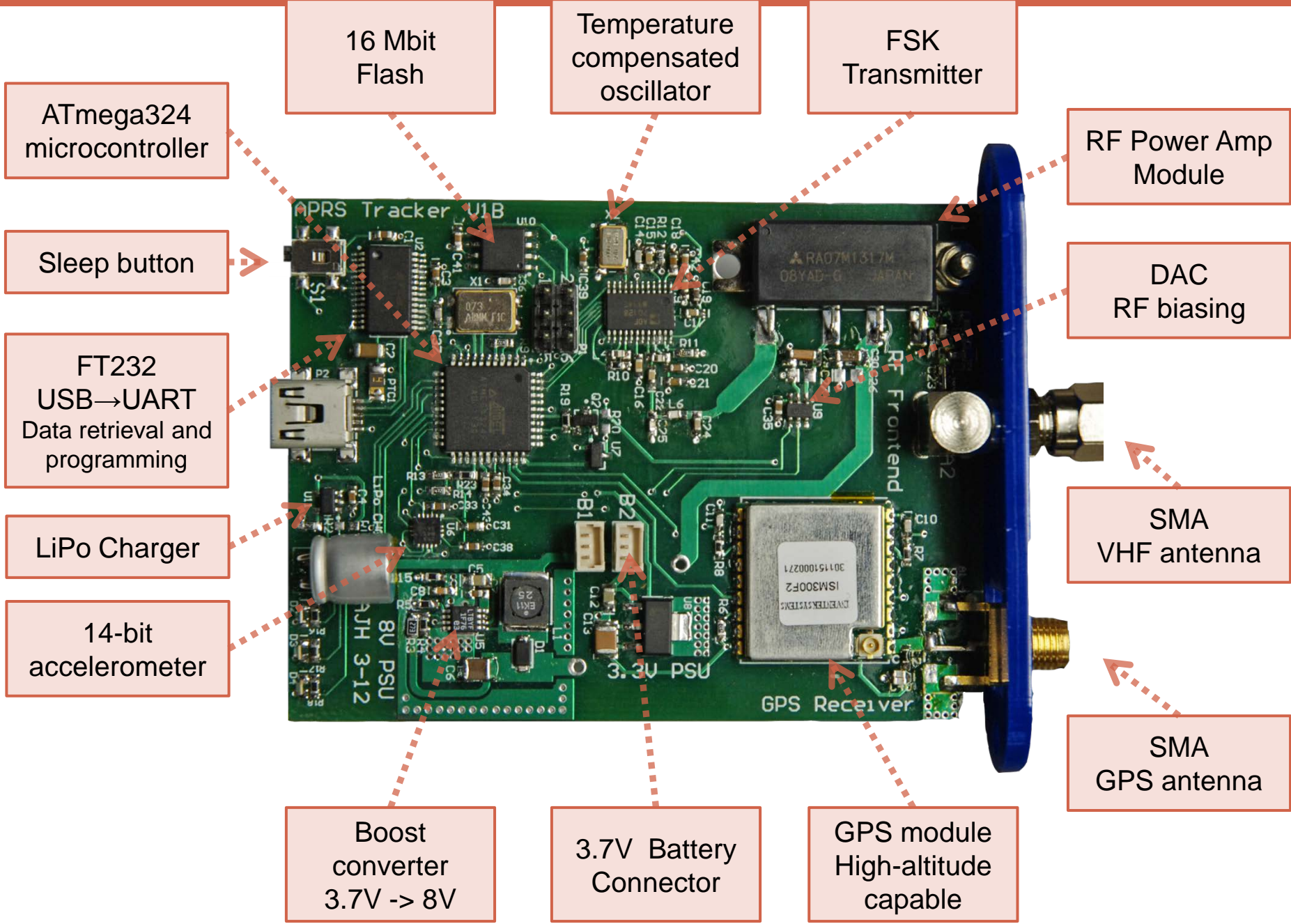
- To create a multi-purpose tracking device with many possible applications.
- A frequency-flexible transmitter, GPS module and high-capacity battery are combined to create a portable and tightly-integrated device.

# Goals

- Frequency-agile transmitter
- High GPS accuracy
- Long battery life
- Tightly integrated package
- Computer programmable
- Charging over USB
- Permit local data logging

# Architecture



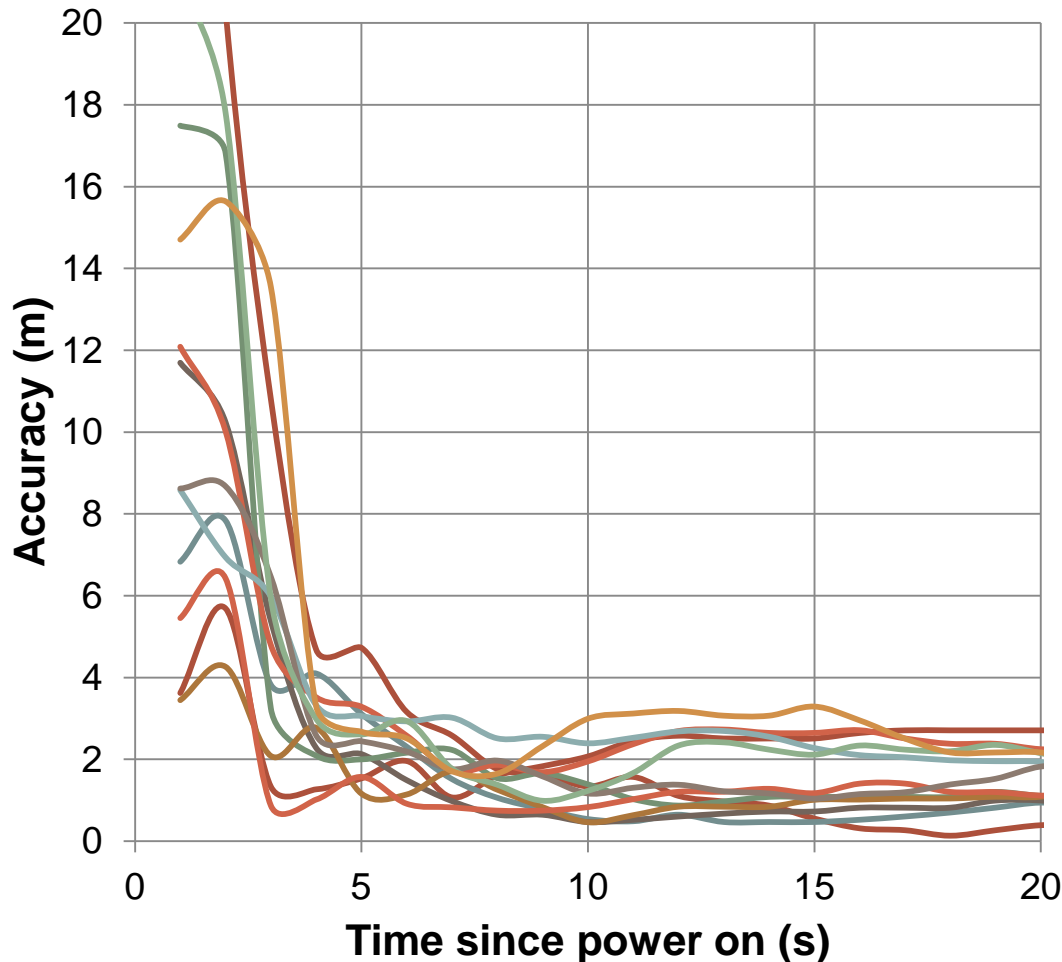


# Experiments

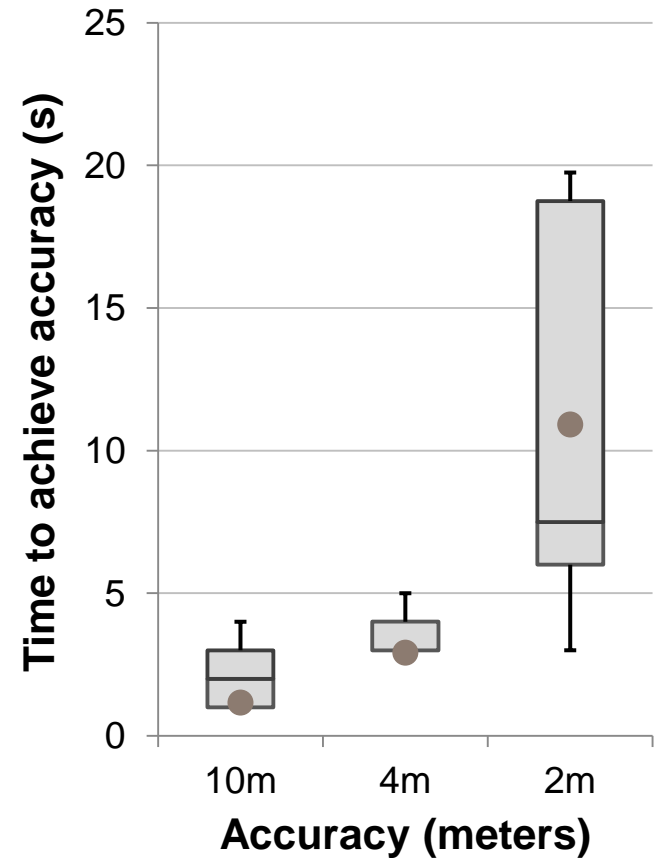
- GPS accuracy over time for hot fix
  - Test how accurate the GPS is immediately after reacquiring location data
- Power consumption
  - Used to extrapolate battery life
  - Long battery life allows for increased transmit rate
- RF transient spectrum analysis
  - Presence of transients and spurious signals determine FCC certification

# Experimental Results: GPS Accuracy

## GPS Accuracy over time, Hot Fix



Turned GPS off for 10 seconds  
Measured time to achieve a  
certain accuracy (10m, 4m, 2m)





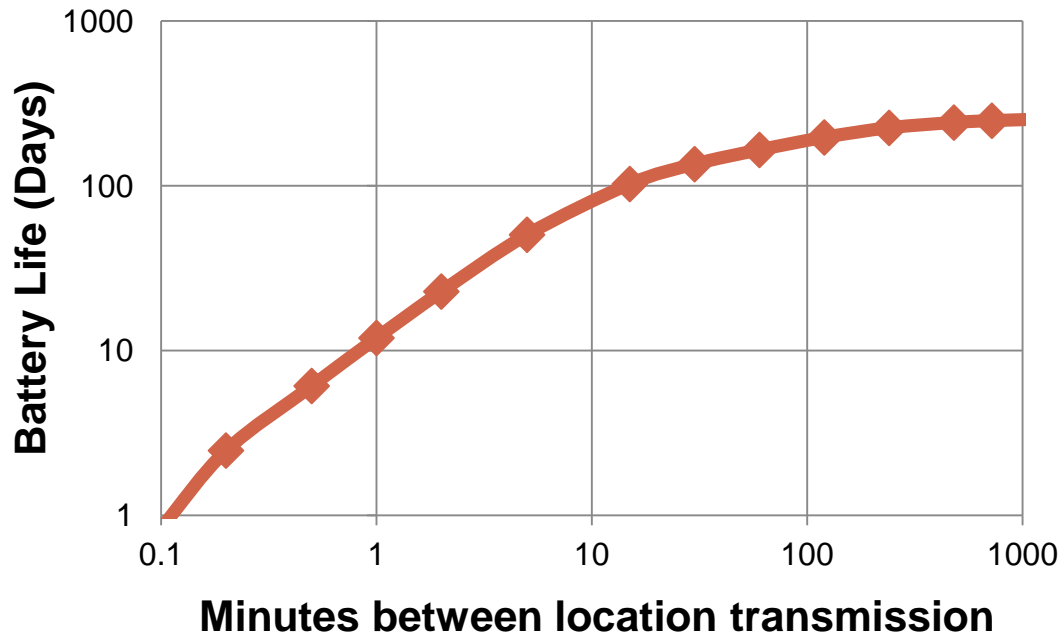
# Experimental Results: Battery Life

Mode	Current
Standby	0.35 mA
Active, GPS	50 mA
Active, Transmitting	850 mA

Extrapolated based on:

- 2200 mAh battery
- GPS hot fix time: 2 – 10 seconds (depending on last GPS fix time)
- Transmits for 0.4 seconds

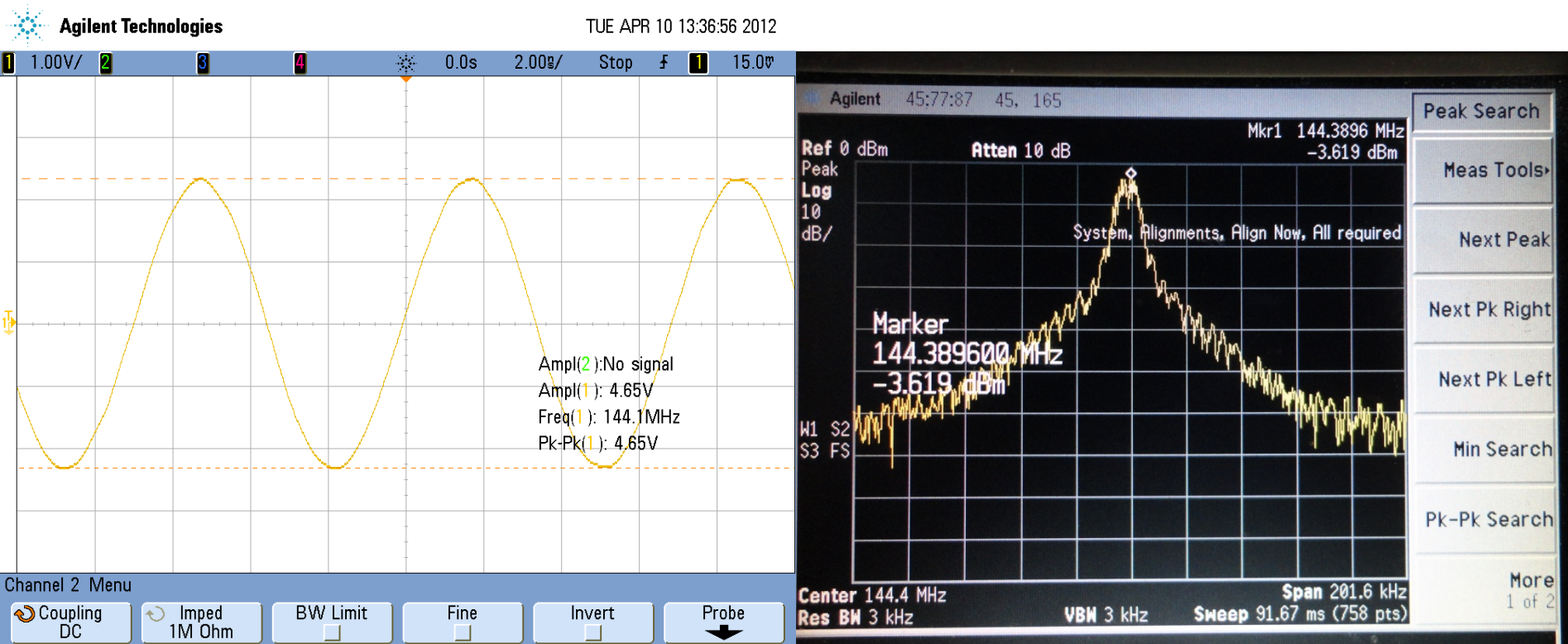
### Extrapolated Battery Life



Transmission Interval	Battery Life
30 seconds	6 days
2 minutes	3 weeks
10 minutes	2.5 months
1 hour	5 months

# Experimental Results: RF Analysis

- 2.5Watt output power
- Free of transients and spurious signals



# Insights from Measurements

- GPS accuracy over time determines battery life
  - Allows us to pick how long to wait before deciding reported GPS data is accurate enough
- Long battery life opens the door for other applications
  - Fast beacon rate
  - High-resolution package tracking
  - Use in emergency situations where power is unavailable
- RF signal free of transients and spurious signals
  - Possible candidate for FCC certification
  - Responsible use of RF spectrum
  - Will not interfere with other radio services

# Performance

- Range
  - Varies with terrain and receive hardware
  - Furthest non-repeated beacon: 13.8 miles
- Power Consumption
  - Auto power-off with wake-on-motion.
  - Multi-month standby time

# Other Features

- Compatibility with worldwide APRS network
  - Repeated signals can travel hundreds of miles
  - Almost all traffic is reported in public database
- Server software
  - For receiving and decoding beacons.
  - Used to track moving and stationary objects
- High resolution accelerometer data
  - 14-bit accelerometer
- High resolution position beacon
  - Increased transmit time but increased accuracy
- Auto power-off and wake-on-motion
  - Controlled by accelerometer

# Open Issues

- Increased output power
  - Device not currently operating at full output power
- Custom packet protocol
  - Creating our own protocol would allow for short transmit time while still achieving high-resolution location information
  - Could be integrated into the private server for custom applications.
- Sine wave-based modulation technique
  - Improve overall range and weak-signal performance
  - Further improve spectral purity
  - Increases compatibility

# Conclusions

- We learned how to integrate devices with the APRS network
- What would we have done differently:
  - Worked earlier on embedded software
  - Use monolithic amplifier from the beginning