# Using Internet of Things (IoT) Networks for Wildlife Tracking

Collin Beane

Division of Science and Mathematics
University of Minnesota, Morris
Morris, Minnesota, USA

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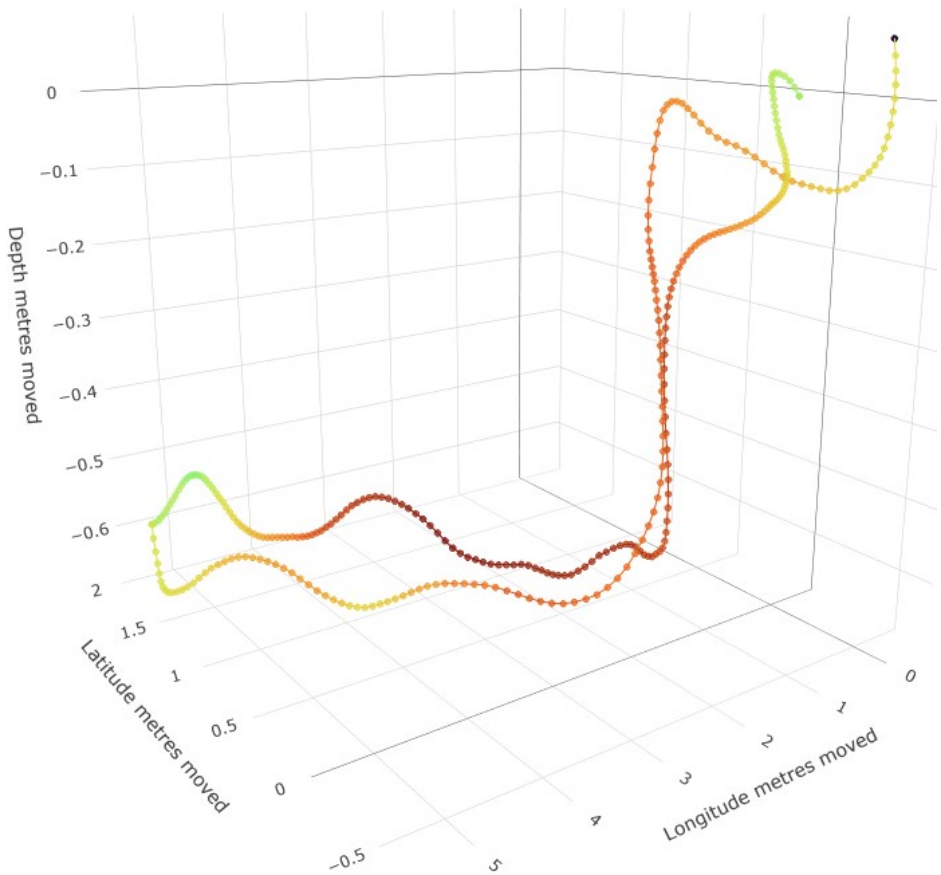
# Outline

# Introduction to Biologging

Figure: Animals With SigFox enabled biologging tags[8]

- Definition: "Investigation of phenomena in or around free-ranging organisms beyond human visibility or experience.[1]"
- Method: Tracking wild animals using electronic devices attached to the animal
- ↑ Popularity in early 2000s, practiced since the 60's
- Pivotal role in understanding animal behavior and ecology

# Applications of Biologging




- Track animal movements, behaviors, and migration patterns
- Collect data on the animal's environment.
- Insights into organisms in hostile or hard-to-reach environments

Figure: 3D movement of a prairie dog [4]

# Impact and Importance

- Study previously inaccessible aspects of animal life.
- Inform conservation efforts and protect endangered species.
- Important tool for data collection
- Interpretation and application are up to scientists and conservationists.

# Other Biologging Methods

- Cellular networks; High Cost
  - High Cost/message
- Radio Frequency (5-1000m)
  - Periodic tracking records
  - Time stamped data

Figure: Pigeons Equipped with cellular trackers [5]

# Data Transmission

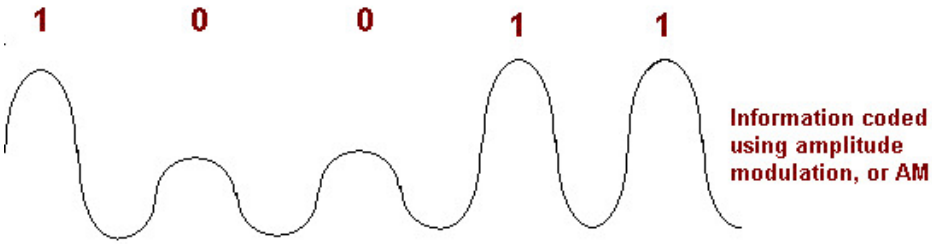



Figure: How data is represented using amplitude modulation[3]

- Data encoded into 1's and 0's
  - Represented by different amplitudes of radio waves
  - Received and translated by other devices

# Common Wireless Network Frequencies

- Home WiFi Frequencies
  - 2.4GHz/5GHz/6GHz
- LPWAN Frequencies
  - $<$1GHz (depends on region)
- As frequency increases, range is sacrificed for higher data rates

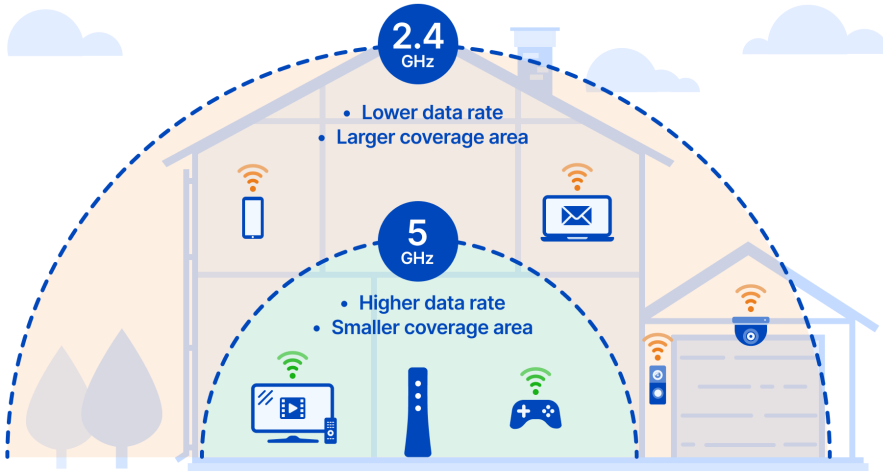



Figure: 5 GHz will give you more signal strength and faster speed over a shorter range, compared to 2.4 GHz.[6]

# Concepts of Wireless Frequencies

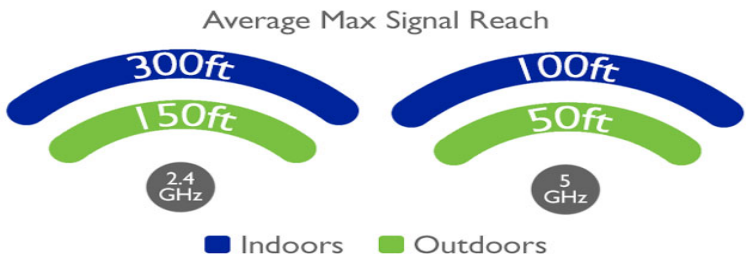



Figure: Comparing Range of frequencies[7]


Figure: Comparing Speed of frequencies[7]

- Higher frequency $\Rightarrow$ higher data rates
  - more ones and zeroes received per second
- Range is more important than speed in some Applications
- Lower frequencies can reach 10's of km vs. 100's of m

# What is the Internet of Things?

- Empowering physical objects with sensors and software for autonomous interaction
- Can either connect via wired or wireless connection
- Many applications: Healthcare, agriculture, and of course conservation

# Layers of an IoT System

- Application Layer
  - Processes and uses data
- Network Layer
  - Establishes connection to internet and IoT devices
  - Transmits data to and from the other layers
- Perception Layer
  - Collects data from the environment or...
  - Interacts with the physical device

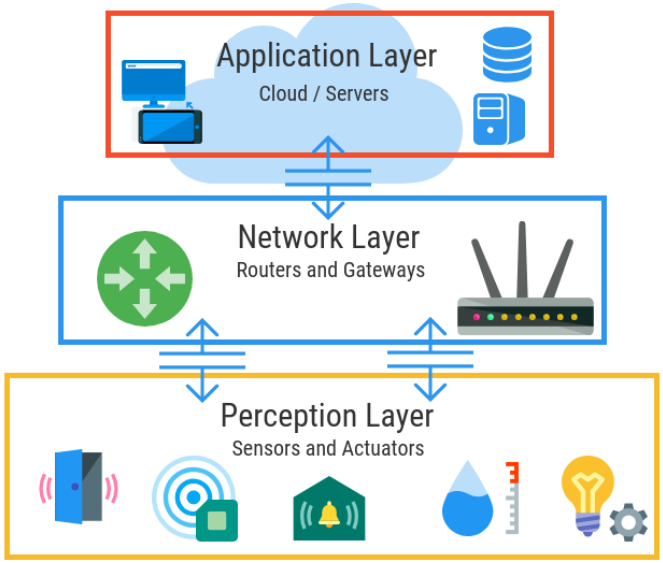



Figure: Layer Structure of an IoT System.[2]

# Base Stations

# Security

# Cost

# References

[1] Ian L. Boyd, Akiko Kato, and Yan Ropert-Coudert. “Bio-logging science: sensing beyond the boundaries”. In: *Memoirs of National Institute of Polar Research. Special issue* 58 (Mar. 2004), pp. 1–14.

[2] Adam Calihman. *IOT architectures - common approaches and ways to design IOT at scale*. Aug. 2021. URL: https://www.netburner.com/learn/architectural-frameworks-in-the-iot-civilization/.

[3] *How is data put on radio waves?* URL: https://www.qrg.northwestern.edu/projects/vss/docs/communications/1-how-is-data-put-on-radio-waves.html.

[4] Abhishyant Kidangoor. *New trackers bring Prairie Dogs' little-known underground life to light*. Mar. 2024. URL: https://news.mongabay.com/2024/03/new-trackers-