PADERBORN UNIVERSITY

Project Group - Sustainable IoT (WS24/25)

Prof. Dr. Lin Wang
Computer Networks Group
Department of Computer Science
Paderborn University

Internet of Things

Infrastructure monitoring

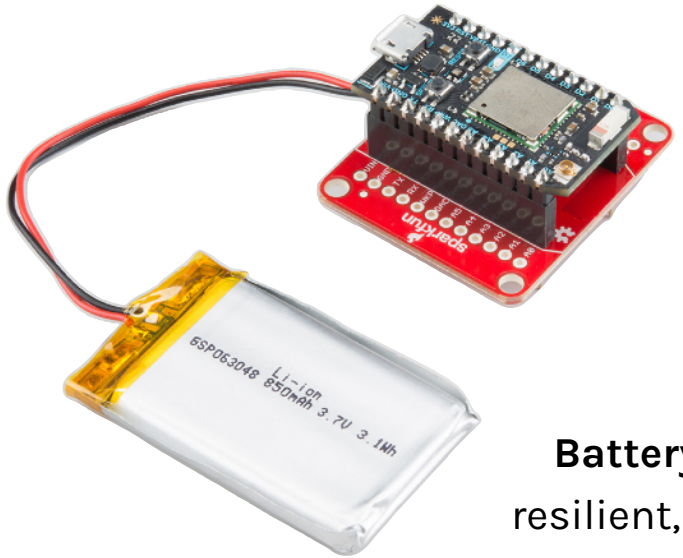
Smart agriculture

Smart transportation

How is IoT traditionally done?

Sensor nodes dispersed in the environment acorss a large area

The Achilles heel of IoT: battery

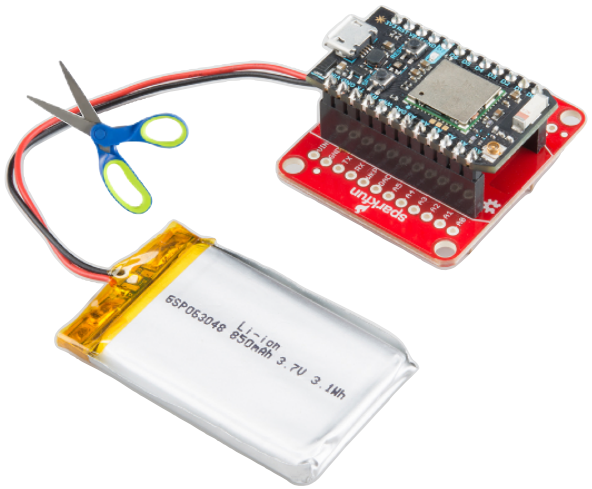


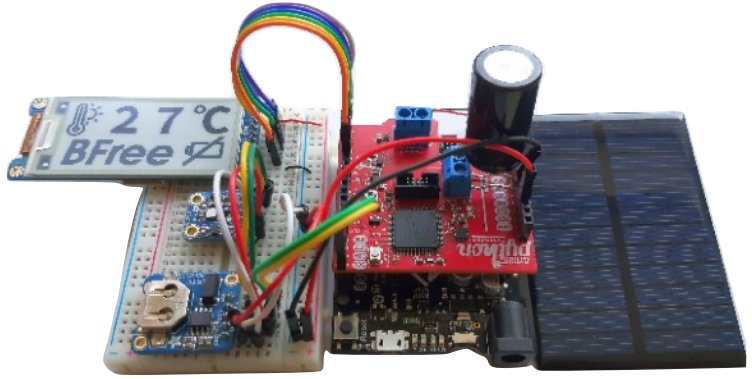
Microcontroller with sensors

Battery: hard to maintain, not resilient, not environment-friendly

IoT is not sustainable due to the onboard batteries!

Battery-free IoT





Capacitors

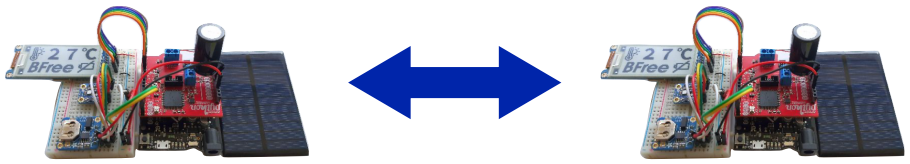
Solar panel, or other energy-harvesting devices

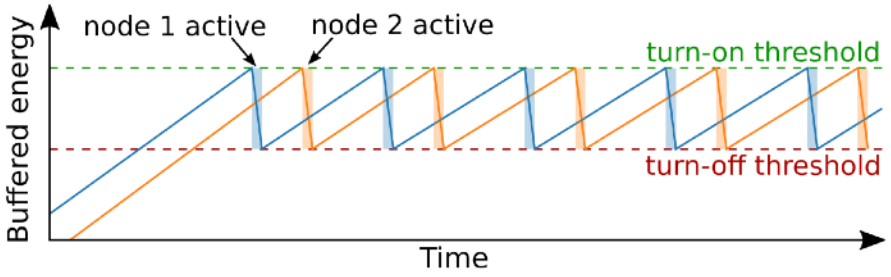
Image from https://github.com/TUDSSL/BFree

Challenge: intermittency

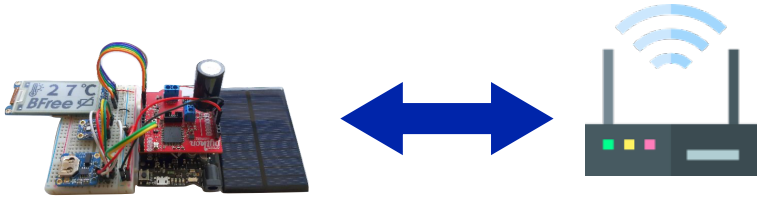
Challenge: communication

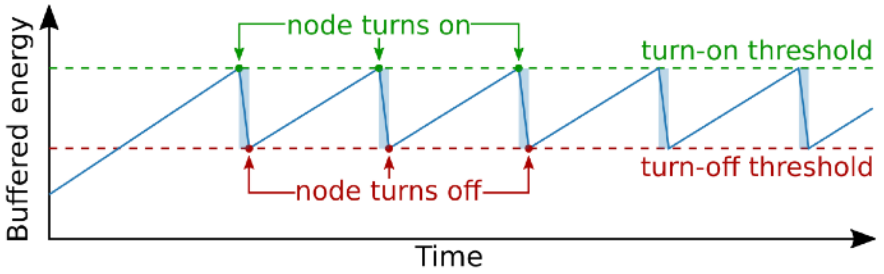
Node discovery and communication





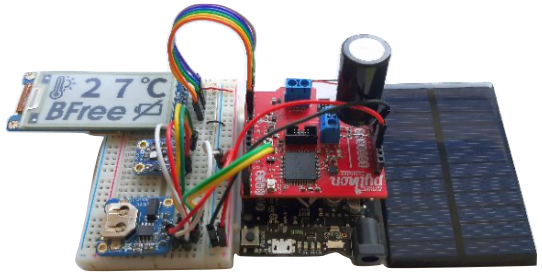
Persistent connection

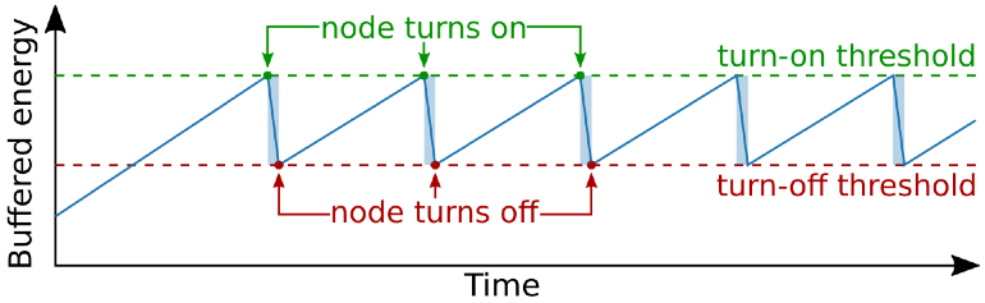




Images from https://github.com/TUDSSL/BFree and https://www.usenix.org/conference/nsdi21/presentation/geissdoerfer

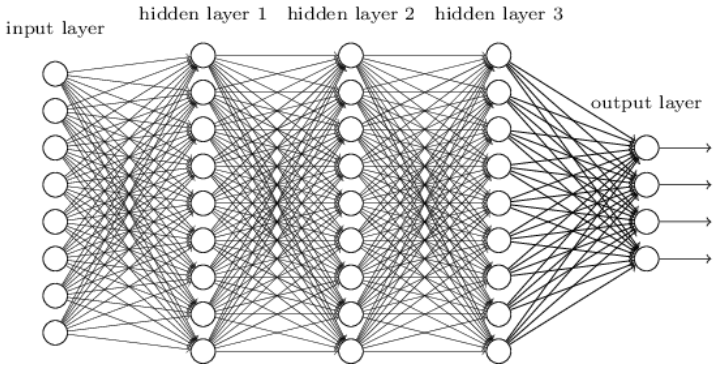
Challenge: computing



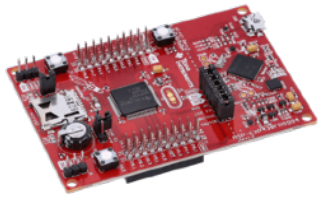


Forward progress of program execution through state management

Challenge: DNN inference

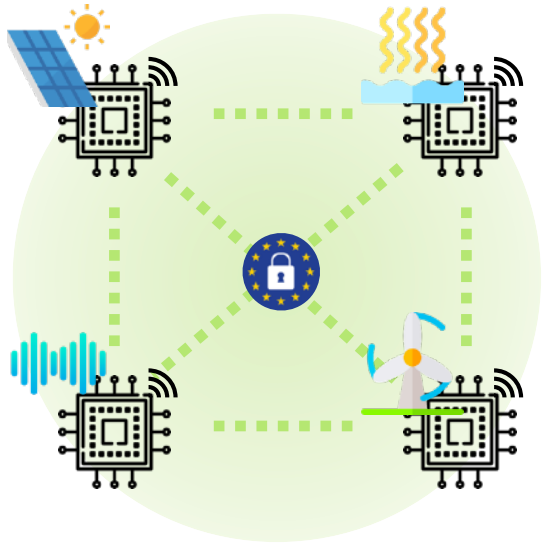


Run DNN inference on small embedded devices efficiently



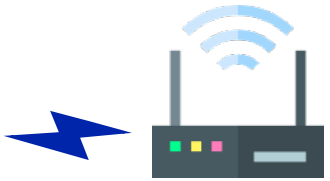
Expected outcome

Smart battery-free sensor nodes



Data exchange between battery-free nodes

Date relay to the gateway



Gateway

Dashboard for detailed statistics

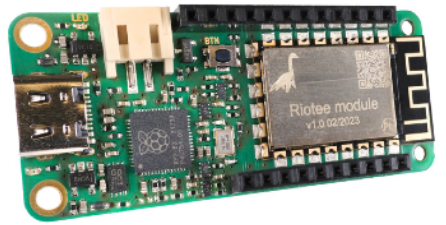
Sub-topic: battery-free devices

Topics

- Discovery and communication between two battery-free devices
- Persistent communication between a battery-free device and a gateway via Bluetooth
- Forward progress of computation on battery-free devices via checkpointing

Expected skills

- Background in wireless communication and networking
- Low-level C programming skills for embedded devices
- Interests in hardware in general



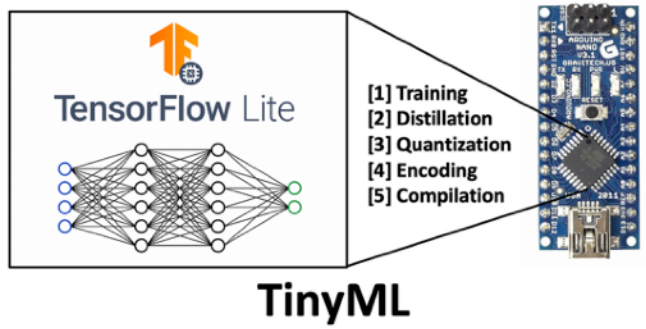
Sub-topic: embedded AI

Topics

- Performance profiling of DNNs on embedded devices
- Efficient execution of DNN models on embedded devices
- Execution of DNN models on battery-free embedded devices

Expected skills

- Background in deep learning
- Low-level C programming skills for embedded devices
- Interests in tinyML in general



Sub-topic: IoT systems integration

Topics

- Sensor data collection, storage, and analytics
- Data visulization

Expected skills

- Background in database and data analytics
- Programming in Python
- Web development

Concrete use cases in our group

Coffee buddy

Door tags

Always-on AI pin