

Meta FAQ

- Do I have to do these exact proposals?
 - No! These are just ideas to seed you, but they are slightly more thought out, so consider what parts you want to vary / why
 - Is there a budget for hardware for projects?
 - Yes! <\$250 is easy, and just assume the answer is yes. >\$250 is do-able, but we'll need to talk just a bit first.
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Smart Agriculture

Microbial water sensors

- Electrogenic bacteria in soil can be used as an energy scavenging source
 - https://www.cjosephson.net/assets/pdfs/Farming_Electrons_Galvanic_vs_Microbial_Energy_in_Soil_Batteries_website.pdf
- We have cells and deployments measuring power generation potential, but little correlation yet between energy output and environmental conditions
- **Project:** Build on existing microbial harvesters to build a predictive model that attempts to use cell electrical output to predict soil moisture
 - Challenges: Many confounding variables (temperature, NPK content, total organic carbon content), some of which we cannot measure

Microbial-powered sensors

- Build a proof-of-concept end-to-end microbial powered system
- We've established the energy harvesting potential of soil bacteria
 - https://www.cjosephson.net/assets/pdfs/Farming_Electrons_Galvanic_vs_Microbial_Energy_in_Soil_Batteries_website.pdf
- Now let's build something interesting
- **One specific pitch:** Build a system that powers an RTC and an e-Ink display. Measuring actual soil moisture is hard (see above), but watering events are easily identifiable. A plant can thus have a self-powered display that shows "Last watered at XX:XX".

Embedded Operating Systems

Application Resource Attribution

- Multi-tenant applications are new to embedded systems
- How should an embedded kernel "fairly" and efficiently track and attribute resource use
 - Particularly for shared peripherals, resources (radio, storage, etc)
 - Related work in the desktop OS space, [powertop](#), [OS X energy monitor](#), etc.
 - Related work in the embedded space:
<https://lab11.eecs.berkeley.edu/content/pubs/adkins18signpost.pdf>

- **Project:** Pick a more accessible resource (e.g. execution time) and modify the [Tock kernel](#) to track and report resource utilization for applications

Continuous Integration for Hardware Platforms

- CI has transformed development for software, but has lagged in hardware
- One major challenge is that system developers often do not have access to *all* hardware platforms — this requires a federated, pluggable design
- **Project:** Build a prototype CI runner that deploys and captures (basic!) test results from real hardware
 - *Challenges:* This is easy to build in one case, and hard to build *right* -- the research question here is the interface for this system

Edge ML

- Replication study
- Pick a paper in the last... 18-30 months... that is trying to get ML working on edge devices. See if you can replicate their results (especially cool if you get it running on a different edge HW platform)
- See if you can find one experiment the original paper didn't run that you wish it had; run that experiment!
- See if the proposed system works well for any *other* application; there are lots of good datasets out there for motion (i.e. gait tracking), or power monitoring (i.e. IV data); see if the general "compression" techniques apply to other types of networks.
- **Candidates:** Any of the ML papers on the schedule are probably good choices (except maybe the cane gesture paper, as that might need HW to get new data)
 - *Challenges:* Make sure you pick something with an accessible dataset -- either the original dataset from the paper or an equivalent dataset that's in scope for the system capabilities

Spectrum

CSE building ambient RF energy study

- Ambient RF energy is been viewed as a promising harvesting source for sensor nodes
- Majority of ambient RF harvesting currently involves a powerful transmitter sending energy pulses, that drive batteryless sensors
- A more realistic approach would be to utilize the ambient RF energy already present. But do we have enough?
- **Project:** In an office building like CSE, what is the profile of RF energy received in different places?
 - Conference rooms, student offices, hallways etc
 - What is the temporal stability, etc?

San Diego Spectrum Study

- Measurement study
- What is the actual spectrum utilization in the greater San Deigo area?
- How much does our topography (hills & valleys) affect the baseline noise in the ambient environment?

Blockchain & the IoT

The hype is big, but what is real?

- There are many companies building blockchain-based IoT products
 - <https://www.netobjex.com/>
 - <https://xage.com/>
 - NEM Catapult (talk to Nishant)
 - <https://daisytron.com/>
- Blockchains are interesting as they are often **public ledgers!**
- Pick a company, download its blockchain, and dissect it -- what can we learn about the actual use of these technologies? Can you find evidence of things that happened in the physical world in data from the blockchain?

Security & Privacy

Contact tracing buy-in

- Can we get an empirical measure of the buy-in of populations?
- Capture an isolated population (fixed # of people), record the BLE environment, estimate %age of folks that have contact tracing turned on
 - Try in multiple environments? Start in the tent with just class to validate (great ground truth available here too); try sitting near a 'choke point' where you can count people (bridge between Hopkins and RIMAC?)