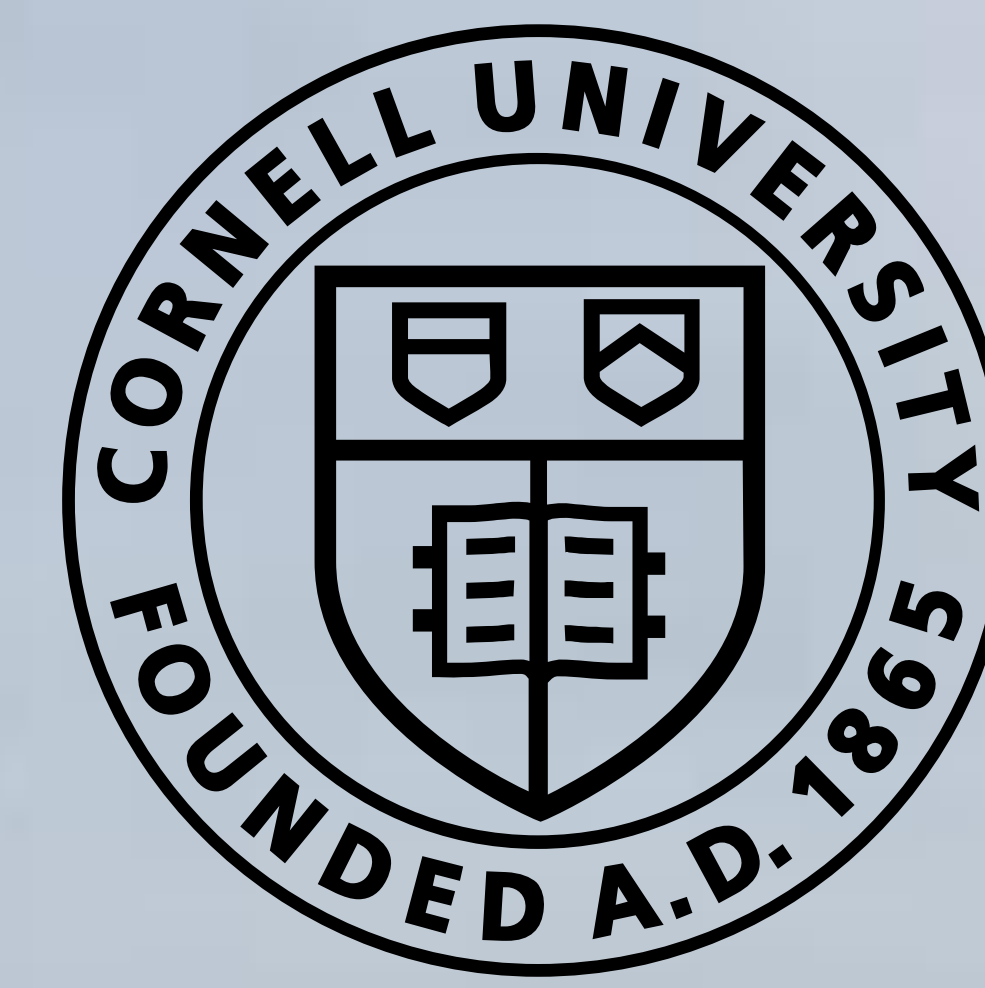# WaterGuard: Toward Cheap Automated Irrigation Systems Powered by the Cloud and TV White Spaces

Gloire Rubambiza, Hakim Weatherspoon, José Martínez, Abraham Stroock

Introduction

To sustainably feed a projected 10 billion people in 2050, we must:
- Reduce crop loss to environmental stresses by 20%
- Increase water use efficiency by 50%
- Increase farm productivity by 67%

The promise of data-driven farming
- Agriculture constitutes approximately 70% of global water usage
- 50% of the irrigation water is wasted to over-watering
- Data-driven farming can reduce water intake

Challenges & Related Work

- Inaccurate sensing due to soil variability
- Limited connectivity due to sparsely populated rural areas
- Irrigation schedules with limited foresight into weather forecasts

Novel Approach

- Detecting drought stress via a plant MEMS sensor implant
- Leveraging free, farm wide connectivity with TV White Spaces (TVWS) and Long-range Radio (LoRa)
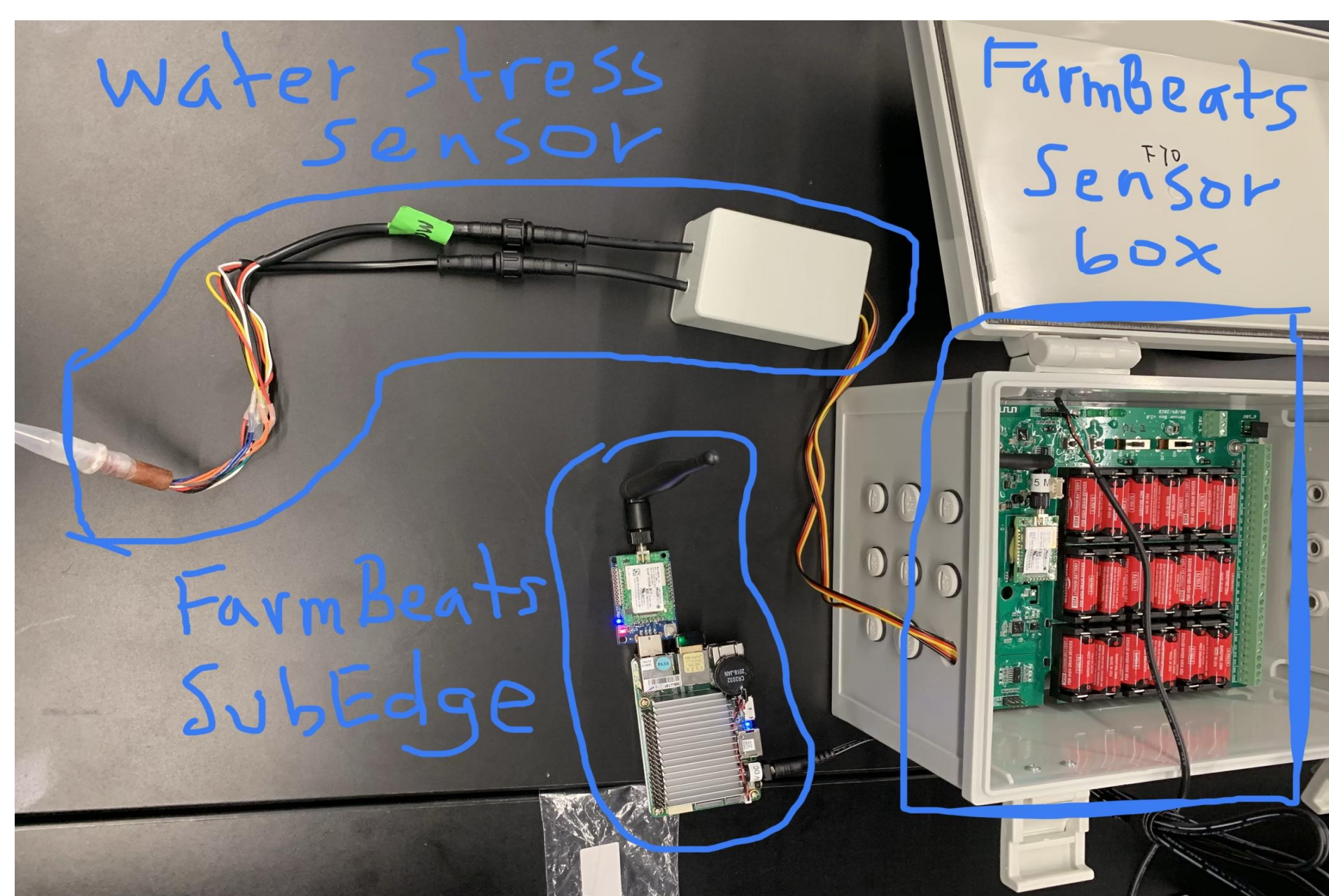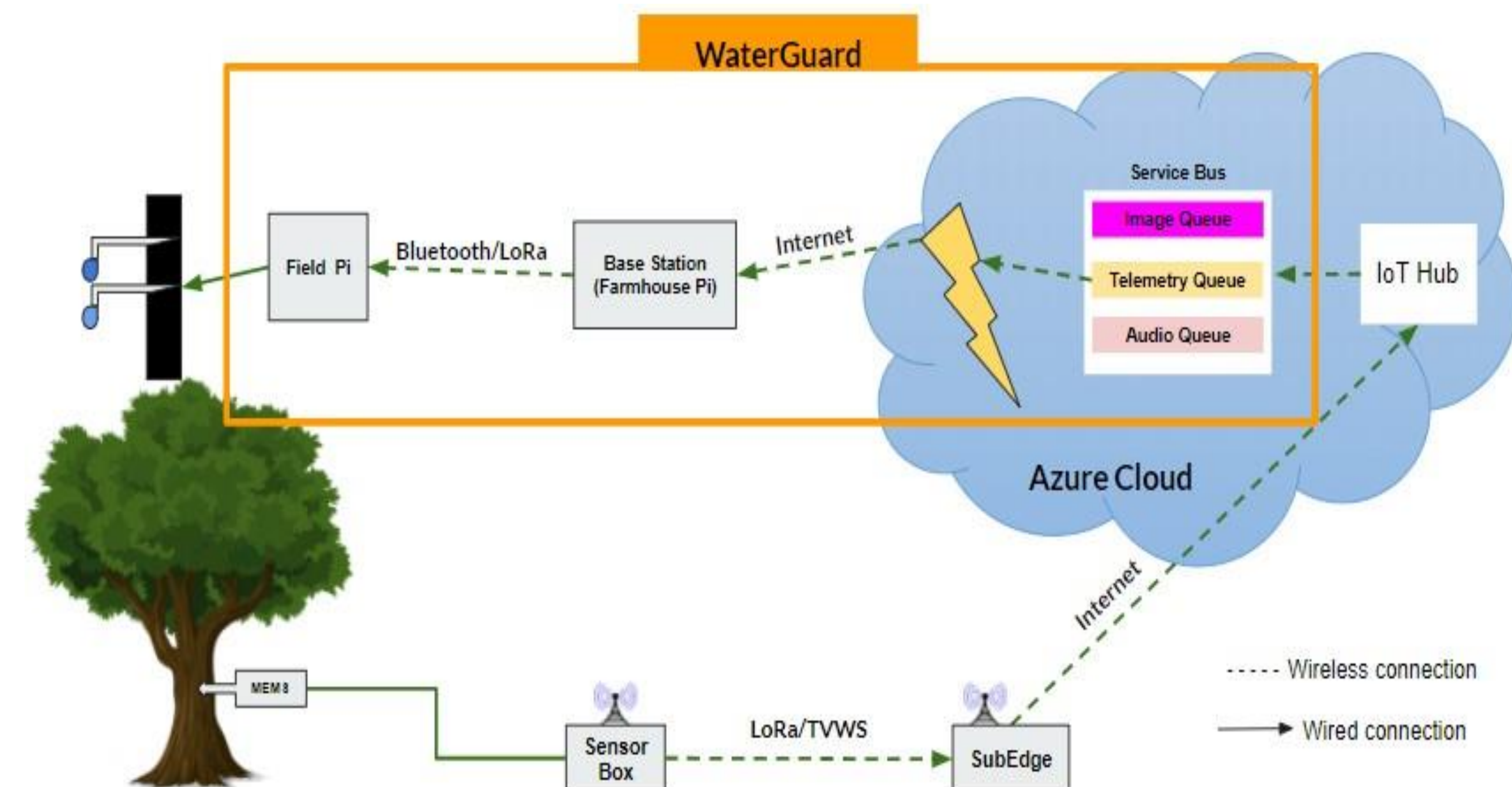- Leveraging scalable, serverless compute in the cloud and optimally placed Raspberry Pis at the farm

Figure 1 Sample FarmBeats Components including a sensor box, SubEdge, and LoRa Radio

## WaterGuard – Achieving Full Automation In Irrigation Systems

Evaluation – Startup and Maintenance Costs

|	Baseline	WaterGuard
Analog-to-digital (A2D) Converter	CR6 ($1500)	Sensor Box (Approx. $200)
Farmhouse Wi-Fi	Hologram Nova 3G Modem ($69 up front cost, $1.50 per device per month + 40 cents per MB transferred)	LoRa Radio ($104) and SubEdge ($225)
Raspberry Pi Kits	$146 * 1 ($146)	$146 * 2 ($292)
Analytics	Ubidots ($49/month for IoT entrepreneur subscription)	Azure Functions ($8 per month assuming 10 executions per hour)
Human Labor Costs	$1920/month	$0/month
Total Startup Cost	**$1715**	**$821**
Total Monthly Cost	**$1971**	**$52**

Table 1: Startup and maintenance costs for a 3G-based, baseline system and WaterGuard. The data transmission costs for the Hologram Nova modem assume 255-byte drought stress data transmitted every 6 minutes. The human labor costs for the baseline assume a $16 per hour pay rate where the human operator performs water stress checks every 4 hours on Ubidots cloud dashboards.

Scaling – Edge vs Remote Actuation
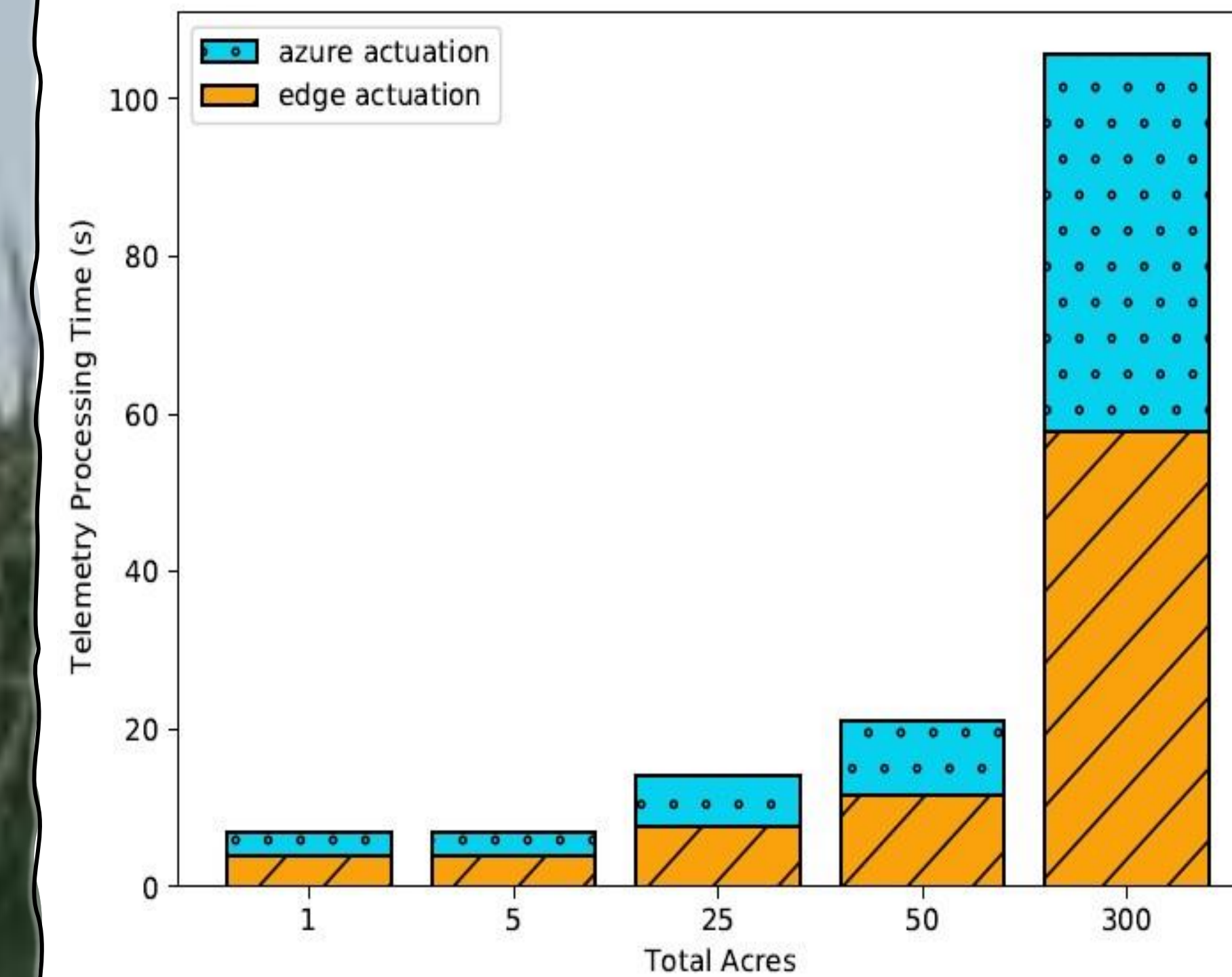
- Bringing the cloud locally with Azure IoT Edge
- Resilience in the face of network outages

Future = Hardware Agnostic
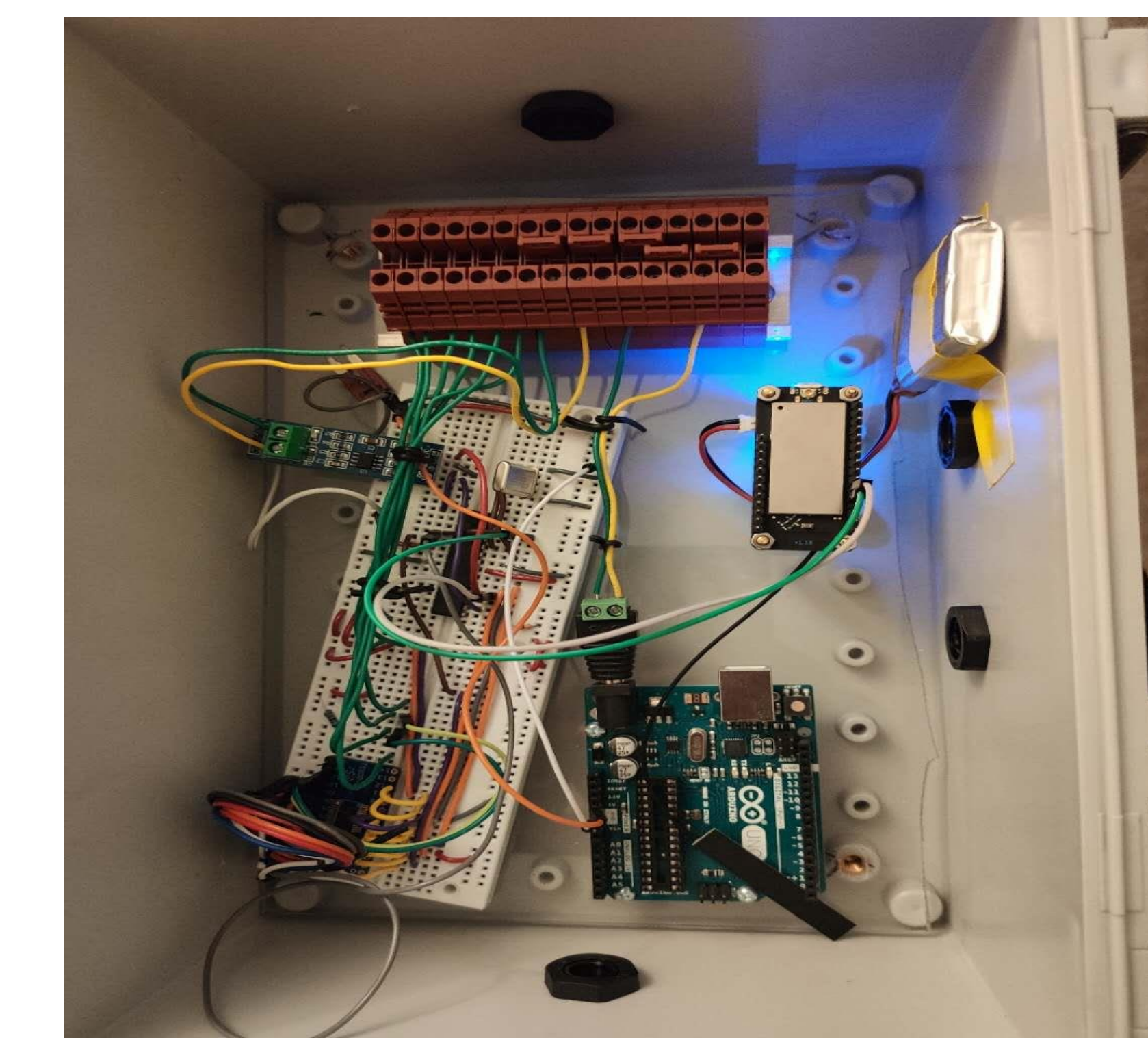
- Soil variability? Model future plant drought stress
- No connectivity? Off-the-shelf network construction
- Limited forecast? Caching during better times

Acknowledgments