IOCAG 2022
The 1st International Online Conference on Agriculture:
ADVANCES IN AGRICULTURAL SCIENCE AND TECHNOLOGY
10–25 FEBRUARY 2022 | ONLINE
agriculture MDPI

Real-Time IoT-Enabled Water Management for Rooftop Urban Agriculture Using Commercial Off-the-Shelf Products

By:

Tamer Almaaitah[1], Darko Joksimovic[1], and Tahmid Sajin[2]

[1]Department of Civil Engineering, Ryerson University, Toronto, ON, Canada

[2]Rogers Communications, Brampton, ON, Canada

Outline

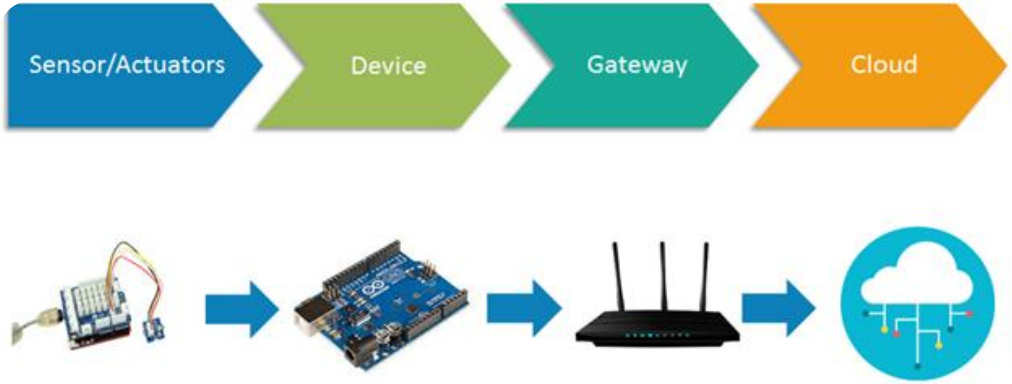
- Introduction: Urban Agriculture (UA) and Internet of Things (IoT)
- Learning objectives
- Study site: Urban Farm Living Lab (UFLL)
- Hands-on guide to low-cost wireless monitoring of rooftop runoff
- Lessons learned and key takeaways

Introduction

ryerson.ca

- Increased interest in urban agriculture and rooftop farming
- The need to:
    - Improve the stormwater management on rooftops farms at a lower cost
    - Inform urban planning and policy
    - Develop design guidance
- Internet of Things (IoT) provides us with new opportunities: Wi-Fi, Bluetooth and LPWAN
- LoRaWAN: long-range transmission and low-power requirement

javatpoint.com



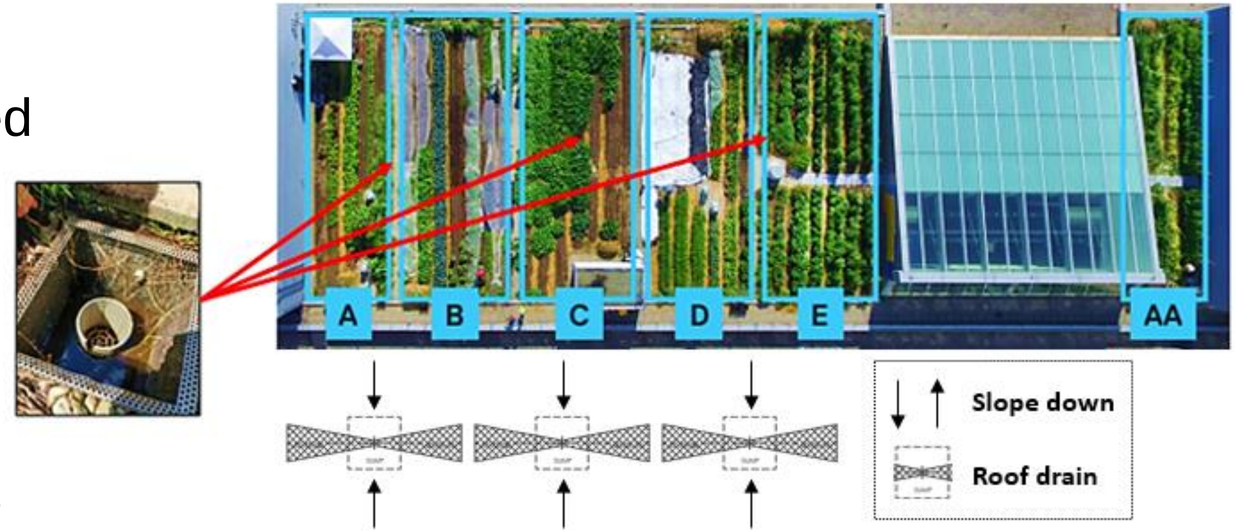
Learning Objectives

The objectives of this presentation are to:

- Understand how the Internet of Things (IoT) can transform the stormwater management of a rooftop farm into a more efficient and innovative process
- Develop a low-cost sensor node that can send data wirelessly through the internet
- Integrate the node into a cloud-based platform and dashboard where data can be accessed in real-time and downloaded remotely

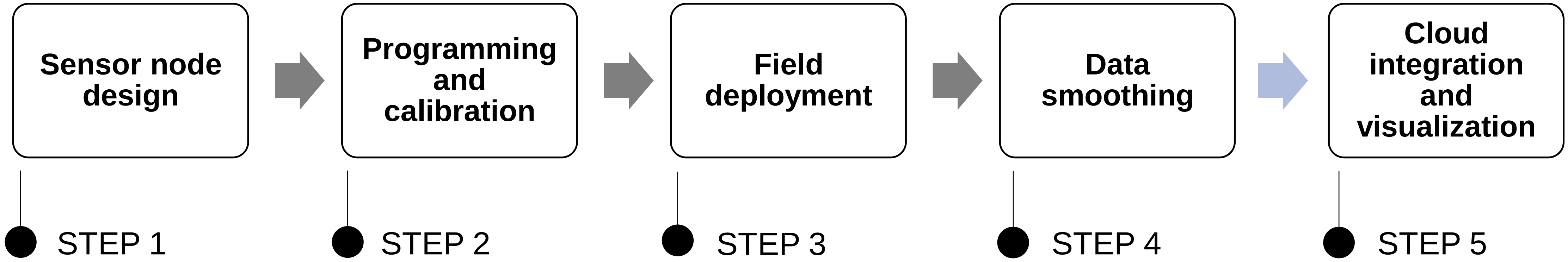
Study Site: Urban Farm Living Lab (UFLL)

- Rooftop of George Vari Engineering and Computing Centre at the campus
- Intensive green roof in 2004 and converted into a rooftop farm in 2014
- Grows around 3,500 to 4,500 kilograms of produce annually
- Split into zones (A, B, C and D) with three roof drains equipped with V-notch weirs
- Weirs were designed to allow flow monitoring



agriculture MDPI

4-Step Hands-On Approach



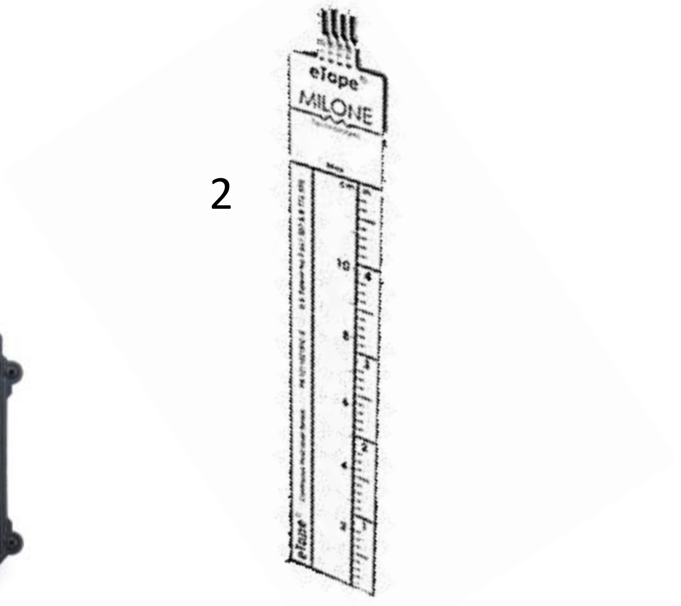
STEP 1: Sensor node design

#	Item	Price in $USD
1	Dragino LSN50 Generic LoRaWAN node	$43
2	eTape liquid level sensor – 5”	$49
3	Polycarbonate tube and housing cap	$14
4	Resistor and wire tube	$8
	TOTAL	**$115**

1

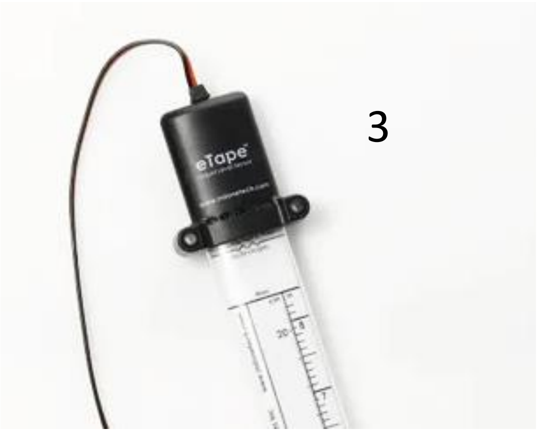
dragino.com

2



milonetech.com/

3



milonetech.com/

4

STEP 1: Sensor Node Design

- Voltage/resistance divider
- Utilizing two pins of the eTape (P2, P3) and a resistor connected between P3 of the eTape and the GND of the LSN50
- P3 of the eTape delivers the analog input in volts
- The resistor can be in the range of 0 to 2000 ohm
- Corrected resistance output can be measured and used for calibration and into the code

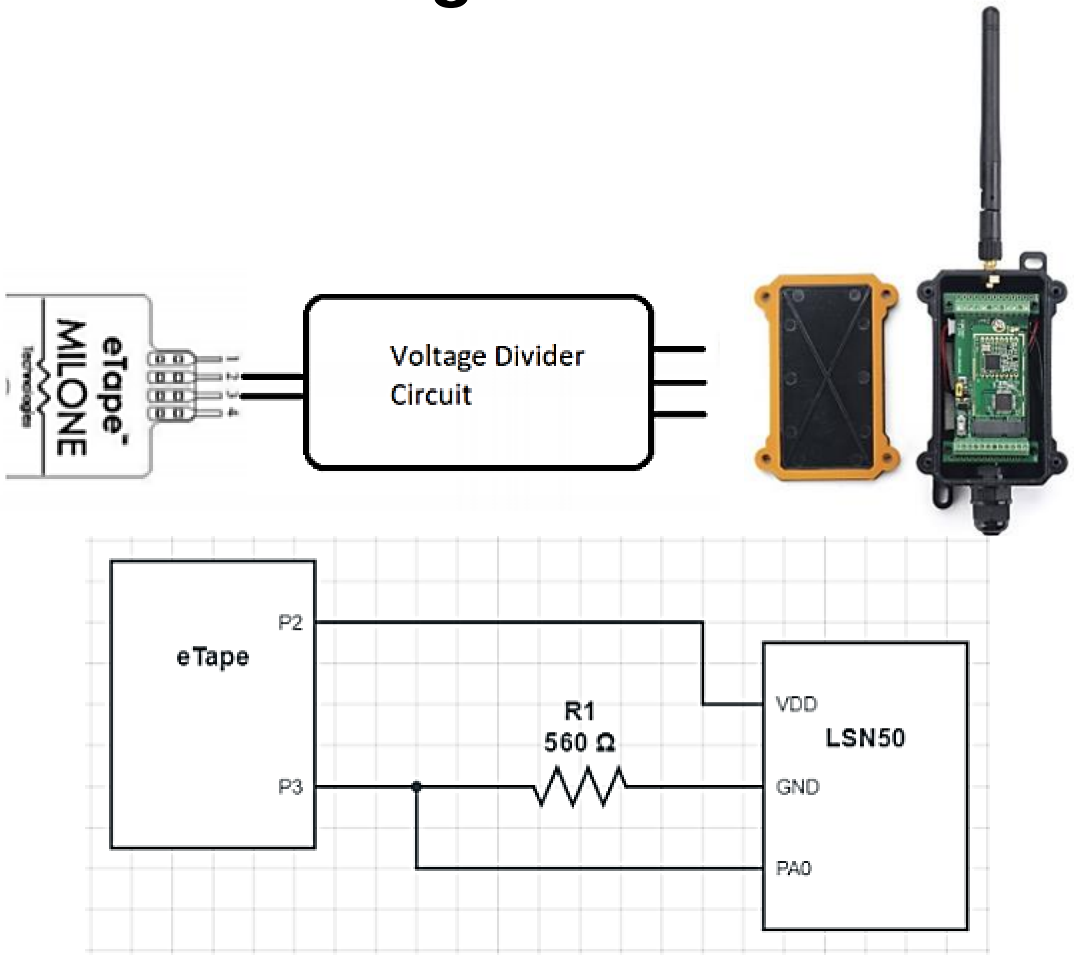


Figure 5b: Voltage divider circuit of eTape.

STEP 2: Programming and calibration

Registration on TTN → Developing a payload → Calibration

THE THINGS NETWORK

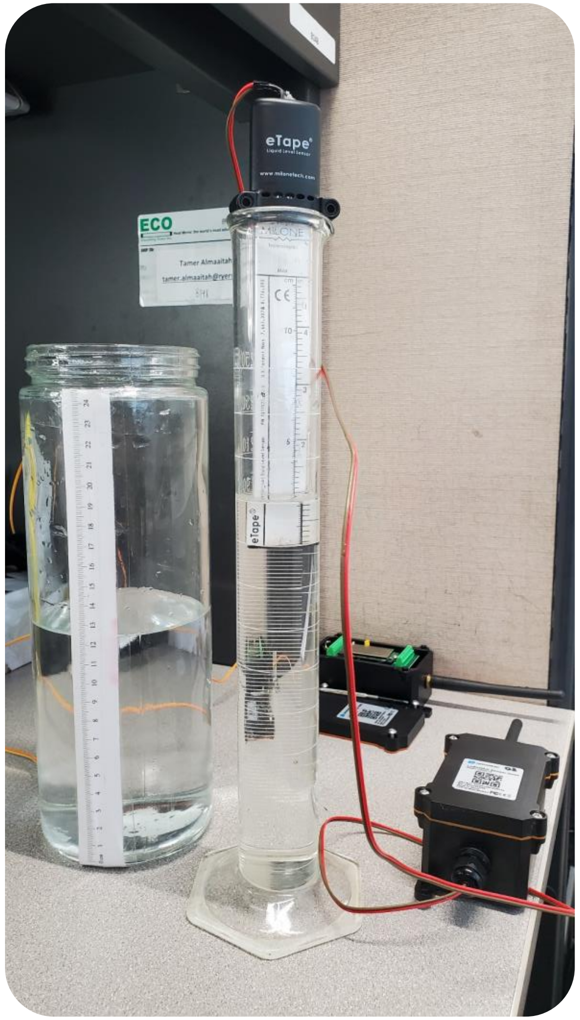
Using:

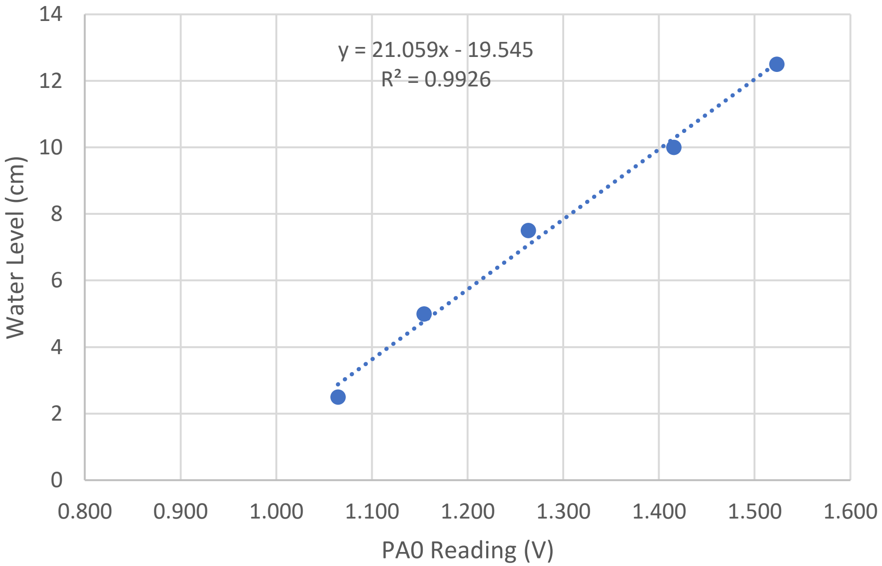
- Device EUI
- APP Key
- Application EUI

- Working with Bytes
- Commercially-available nodes usually come with their own payloads
- <u>Slight modification may be necessary</u>

- Varying water level to get the corresponding voltage reading

STEP 2: Programming and calibration



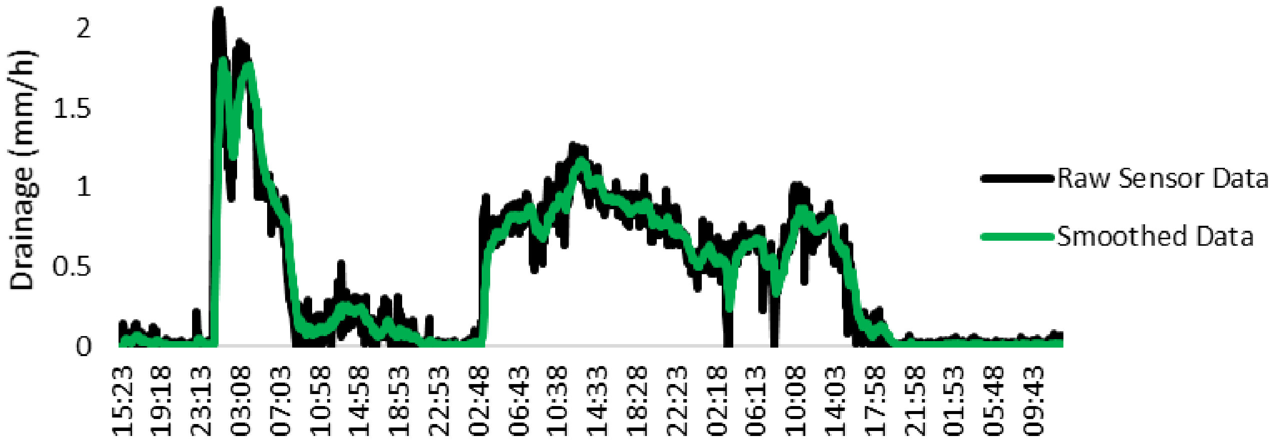


Varying water level to get
the corresponding voltage reading

STEP 3: Field deployment

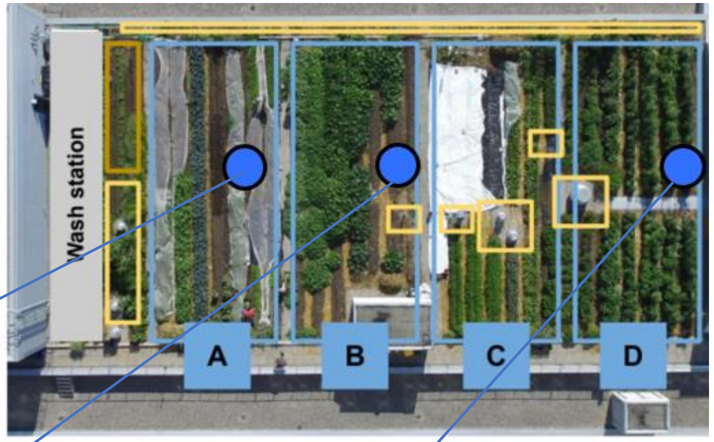
STEP 4: Data Smoothing

- The developed sensor node provided consistency and high-quality data over the season
- To address the sensor noise, water level data were smoothed to reduce dispersion and remove outliers using the exponential smoothing (ES) method.

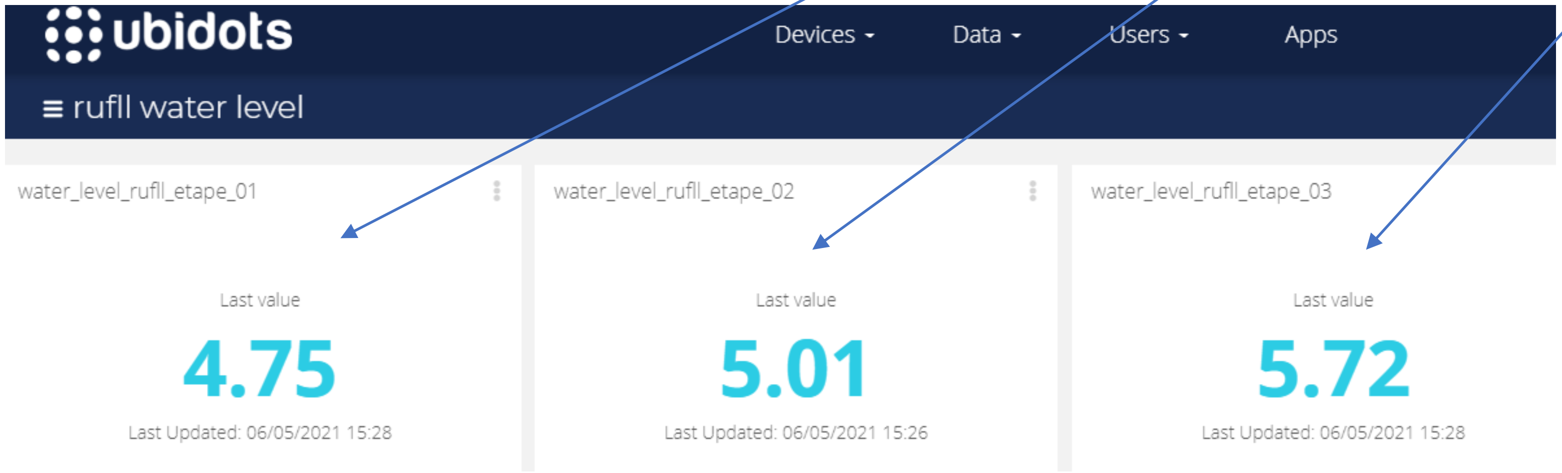


STEP 5: Cloud integration and visualization

- A variety of IoT platform integrations to receive messages from sensors through TTN
- Ubidots has been used for this study
- Store and visualize data

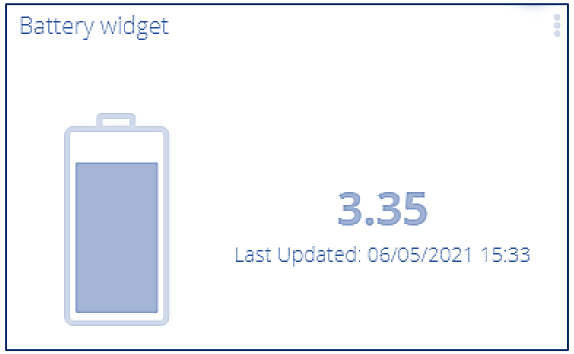


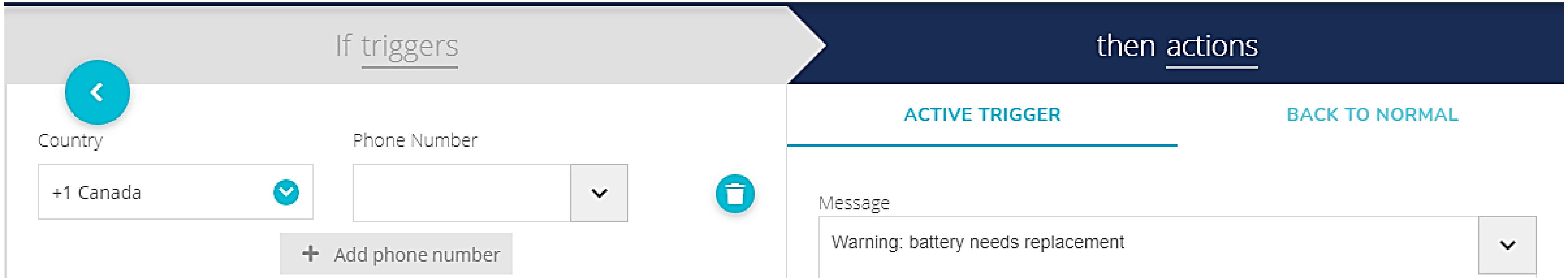
All water level measurements are in cm



STEP 5: Cloud integration and visualization

- Create conditional events and alerts
- Reducing site visits and possibility of losing data!





Lessons learned and key takeaways

- Careful water use and managed stormwater have become imperative in achieving sustainability goals through urban farming
- The reduced cost of sensors and communication nodes and the availability of open-source projects encourage the runoff monitoring of rooftop farms
- Wireless sensor nodes allow easier deployment of various sensors and increase flexibility for monitoring
- Future research will have to analyze energy usage and optimization further

IOCAG 2022
The 1st International Online Conference on Agriculture:
ADVANCES IN AGRICULTURAL SCIENCE AND TECHNOLOGY
10–25 FEBRUARY 2022 | ONLINE
agriculture MDPI

Real-Time IoT-Enabled Water Management for Rooftop Urban Agriculture Using Commercial Off-the-Shelf Products

End of Presentation – Thank You

Tamer Almaaitah[1] *, Darko Joksimovic[1], and Tahmid Sajin[2]

*** tamer.almaaitah@ryerson.ca**