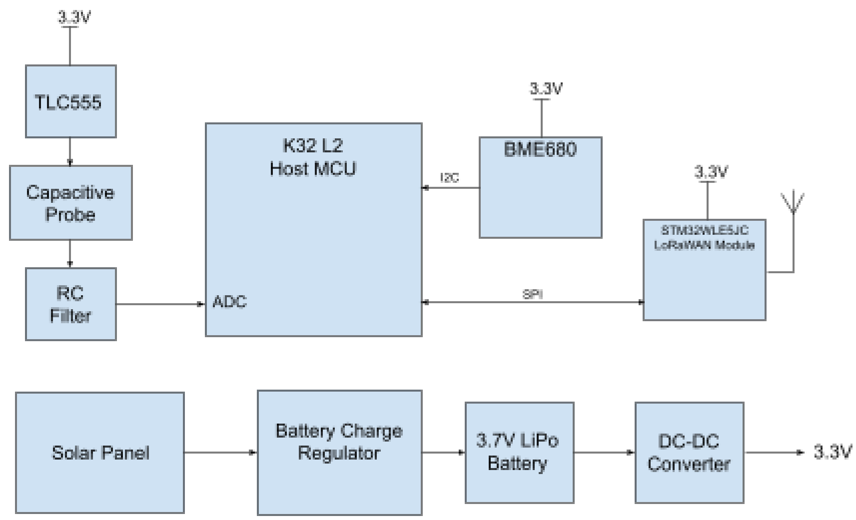
Summary:

Wildfire Early Detection System (WildEDS) is just that. It is an IoT platform that would take data from multiple sensors and transmit that data to a cloud server. Then utilizing a machine learning model that data could be used to predict an area's susceptibility to a wildfire. Wildfires are a growing problem in our world today and many factors like temperature, soil moisture, humidity and pressure can be attributed to them. The goal of this project is to develop an IoT platform that would monitor these features using multiple sensors in order to give firefighters and environmental scientists an edge in predicting where a fire may start.

System Design Formulation and Specification:



a. Hardware System-Level Description

The proposed block diagram in figure 2.1 shows a single WildEDS node that shall communicate with a LoRa gateway to transmit gathered data to a cloud server for future analysis. Each node will be capable of transmitting and receiving (TX/RX) in to give nodes farther from a gateway to transmit their data to closer nodes. A node will be powered by a 3.7V 2500mAh lithium polymer (LiPo) battery which will be capable of charging via a 2W 6V solar panel. The supply voltage is then stepped down to 3.3V using a DC-DC converter with about 90% efficiency.

Soil moisture level is measured using a capacitive probe that utilizes a TLC555 timer to provide an analog signal that can then be processed by the ADC on the K32 L2 which runs at 12MHz in 16-bit mode. The BME680 is a digital sensor that can be used to measure ambient temperature, humidity and barometric pressure. The BME680 will communicate with the K22 L2 via I2C at 400 kHz.

The LoRa-E5 is a LoRaWAN module capable of TX/RX and includes multiple frequency plans including 915MHz. The module consists of a modem MCU, STM32WLE5JC, in conjunction with the SX126X LoRa chip to handle TX/RX communications. The device shall use a 3dBi omni directional dipole antenna which should give the device a range of about 5 miles.

b. Software System-Level Description

Both the LoRa-E5 module and K32 L2 MCU will be programmed to communicate with each other with environmental data being transferred via SPI and AT commands sent using UART. All programming will be done in C/C++ using uCOS real time kernels.

LoRaWAN uses communication protocol IEEE 802.11ah and is license free.

Development Plan:

a. Schedule

Week Of	Goal
Winter Break	Finalize Parts List
Jan 10	Revise system design and further research LoRa Protocol
Jan 17	Further Research LoRa protocol and establish communication between 2 LoRa devices
Jan 24	Revise Parts list if parts have not arrived and Prototype system Design
Jan 31	Prototype System Design
Feb 7	Design PCBs
Feb 14	Design and order PCBs
Feb 21	Assemble and test PCBs
Feb 28	TBD
Mar 7	TBD
Mar 14	TBD
Mar 21	TBD
Mar 28	Software Design
Apr 4	Software Design and Review
Apr 11	Software Design and Review
Apr 18	Software Design and Review
Apr 25	Software Design and Review
May 2	Software Design and Review
May 9	TBD
May 16	TBD
May 23	TBD
May 30	TBD

June 7	Demonstration day

*Note: Tasks will be split evenly among team members with Baldeep working primarily with LoRa/modem MCU and Joss working on sensors/host MCU.

b. Hardware/Software Required

Equipment/Software	Intended Use	Source
Oscilloscope/Function Generator	Analysis of analog/digital signals	WWU Lab
Digital Multimeter	Measuring electrical characteristics	WWU Lab
Surface mount solder station	PCB soldering	WWU Lab
Altium	PCB design	WWU lab/home computer
Multisim	Circuit simulation/prototyping	Lab computer
MCUXpresso	IDE for K32	Lab/home computer

c. Potential Problems

Implementing LoRa could be potentially problematic as members of the team have never used it before. Another potential issue is the design of the battery charger using solar. We have no experience with utilizing solar to charge a LiPo battery and certain measures must be taken to not damage the circuit or the panel.

d. Safety Plan

The largest safety concern is safe handling of the LiPo battery as puncturing the outer casing can cause a fire.

e. Demonstration Plan

- Poster board
- Sensor Demonstration
- Demonstration of data package being sent via LoRa
- Small table area for demonstration

APPENDIX A - Preliminary Parts List and Cost Breakdown

Part	Part Number	Distributer	Manufacturer	Quantity Per Node
Host MCU	K32L2	Digikey	NXP	$5.30
Modem MCU	STM32WLE5JC	Mouser	STM	$6.06
Gas, Humidity, Pressure, Temperature Sensor	BME680	Mouser	Bosch	$7.47
5-5-5 Timer	TLC555	Mouser	Texas Instruments	$0.94
LoRa Module	SX126X	Mouser	Semtech	$4.77
Solar Panel	P126	OCO Voltaic	OCO Voltaic	$19.00
Battery Charge Regulator	LT3652EMSE	DigiKey	Analog Devices Inc.	$4.87
DC-DC Converter	TPS63020DSJT	Mouser	Texas Instruments	$2.60
3.7V 2500mAh Lipo Battery	LP785060	Mouser	Adafruit	$14.95
Custom PCB				$5.00
			BOM	$70.96
			MSRP	$212.88

APPENDIX B -

Part	Purpose	I_D (3.3V)
K32L2	MCU	8.7mA
BME680	Temperature, Humidity, Pressure Sensor	8.9uA
TLC555	Capacitive Soil Moisture Sensor	600uA
LoRa-E5 STM32WLE5JC+SX126X	LoRaWAN	111mA (Tx) 50mA (Rx) 2.1uA (Sleep)
LT3652EMSE	Battery Charge Regulator	52.5 uA
TPS63020DSJT	DC-DC Converter	50 uA
Total		120mA (Tx) 59mA (Rx) 9.4mA (Sleep)

Battery life calculations:
Battery Life Requirement: 1 week/168hrs

Assuming the worst case, sensors will sample every 5 minutes.
K32L2: $8.7mA/sample * 12\ samples/hr = 104.4mA/hr$
BME680: $8.9uA/sample * 12\ samples/hr = 106.8uA/hr$
TLC555:$600uA/sample * 12\ samples/hr = 7.2mA/hr$
LoRa-E5:$111mA/sample * 12\ samples/hr + 50mA/sample * 12\ samples/hr + 2.1uA * 48 = 1.93A/hr$
LT3652EMSE:$52.5uA/sample * 12\ samples/hr = 0.63mA/hr$
TPS63020DSJT:$50uA/sample * 12\ samples/hr = 0.6mA/hr$
$In\ total: 2.15A/hr * 168hrs = 361A/hr\ battery$

Note: The calculated battery life assumes no charging from the solar panel and an unrealistic sampling rate for the duration of a week. A more reasonable estimate is provided below

K32L2:
$8.7mA/sample * 4\ samples/hr * 12hrs + 8.7mA/sample * 2\ samples/hr * 12hrs = 0.6264A/day$
BME680:
$8.9uA/sample * 4\ samples/hr * 12hrs + 8.9uA/sample * 2\ samples/hr * 12hrs = 0.641mA/day$
TLC555:
$600uA/sample * 4\ samples/hr * 12hrs + 600uA/sample * 2\ samples/hr * 12hrs = 43.2mA/day$
LoRa-E5:
$(111mA + 50mA *+ 2.1uA * 13) * 12hrs * 4samples + (111mA + 50mA *+ 2.1uA * 13) * 12hrs * 2samples = 8.7A/day$
LT3652EMSE:
$52.5uA/sample * 4\ samples/hr * 12hrs + 52.5uA/sample * 2\ samples/hr * 12hrs = 3.78mA/day$
TPS63020DSJT:
$50uA/sample * 4\ samples/hr * 12hrs + 50uA/sample * 2\ samples/hr * 12hrs = 3.6mA/day$

$In\ total: 9.37A/day * 7days = 2.73A/hr\ battery$

Sleep mode: 2500mAh/9.4mA = 11 days 1 hour 57 minutes
TX mode: 2500mAh/120mA = 20 hours 49 minutes