Team #14

Team members: Jack, Luke, Peter, Nicolas, Matthew, Mayank

Device/Project Name: SWARM Tech

Need Statement & Design Criteria

Current Needs Statement

Lola's Bees is a beekeeping nonprofit organization that wants to increase their effectiveness and accessibility tracking humidity, temperature and weight of their hives by receiving data remotely and organized based off specific ranges while clients are notified if unstable thresholds have occurred. This is because bee vitals collections procedures are expensive and time consuming, which requires the beekeeper to be on-site and does not yield accurate results.

Constraints and Objectives

Obj #	Objective Description	How to Measure	Normalized Weighting*
1	Record and measure humidity in beehive remotely	With working humidity sensor	0.089152626
2	Send the acquired data to a mobile device app	With working server/aws	0.041114761
3	Organize information gained from sensor on website organized by hive, time, and data type (interactive view)	With web application	0.21881954
4	Track temperature of cluster specifically/Track location of bees in the hive relative to temperature at top/bottom	With automated heat tracking sensor	0.055526121
5	sort information on an excel sheet, ranked by date and data type	With completed, working excel sheet	0.098159726
6	Send information via SMS messages to a server that will update the website	With working SMS messages	0.228709689
7	Can be replicated by other beekeepers/work with varying beehive designs	By using less invasive maneuvers	0.178022677
8	On-site data gathering take less than 5 minutes	By usinga remote system	0.090494861

Cstr #	Constraint Description	How to Verify
1	Need to measure weight, temperature, and humidity of the beehive remotely	Client can receive the three variables off-site in a timely fashion
2	Leave the hive fully intact/safe for bees/minimal disruption	No visible effect on bees and current bee habits are not restricted
3	collect data from multiple hives	The device can be reproducible, or a singular device can collect data from more than 1 hive
4	Spend less than $50 per hive	project costs equal to or less then price goal
5	Be able to store information to download on site	There is a memory card/storage device on site collecting all data
6	Needs to be able communicate/notify if something is wrong	The website and/or app should have a notification feature to alert client
7	Can safely monitor the colony without being affected by wildlife/natural conditions	All electronics are covered, and materials left open should be able to with stand variables, will be verified by prior testing and monitored when implemented
8	Long lasting battery life	Device should be able to run for a long period of time without needing maintenance (2 weeks-month), battery life will be tested prior and monitored when in use
9	Product should have a long-life span, 2 – 5 years	This constraint will be considered when making each aspect, ensuring it is made from quality material and online services are sustainable for the client, to be verified the client can monitor once implemented
10	Product should be easy to remove and apply when needed	Product should have easy attachment points; this will be taken into consideration during production and verified during testing

Overall Device Design

Component	Beehive	Arduino	Website
Function	The temperature and humidity sensor sits at top of hive while 4 weight sensors are at the bottom supporting the hive	The Arduino records data 4 times a day that is then sent to the server using SMS messaging	The website organizes data and makes it accessible to the client
Connection between components	The Sensors are all connected to insolated wires that connect to the Arduino	The Arduino uno holds 8 beehives worth of sensors.	Website is available on mobile phones or laptops

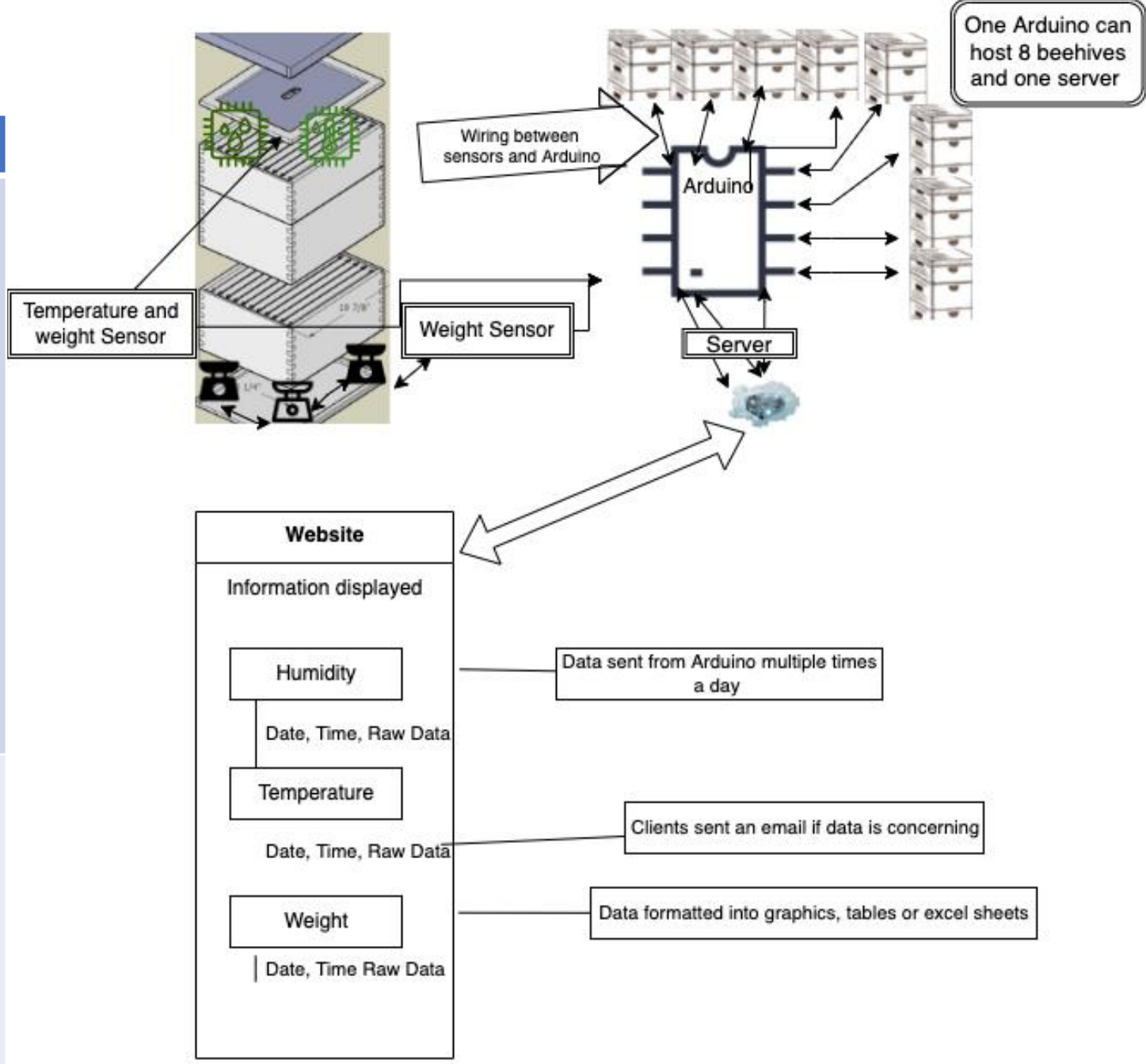


Figure 1: Communication Diagram/flow diagram for whole design

Subsystem Designs – Circuitry/Arduino

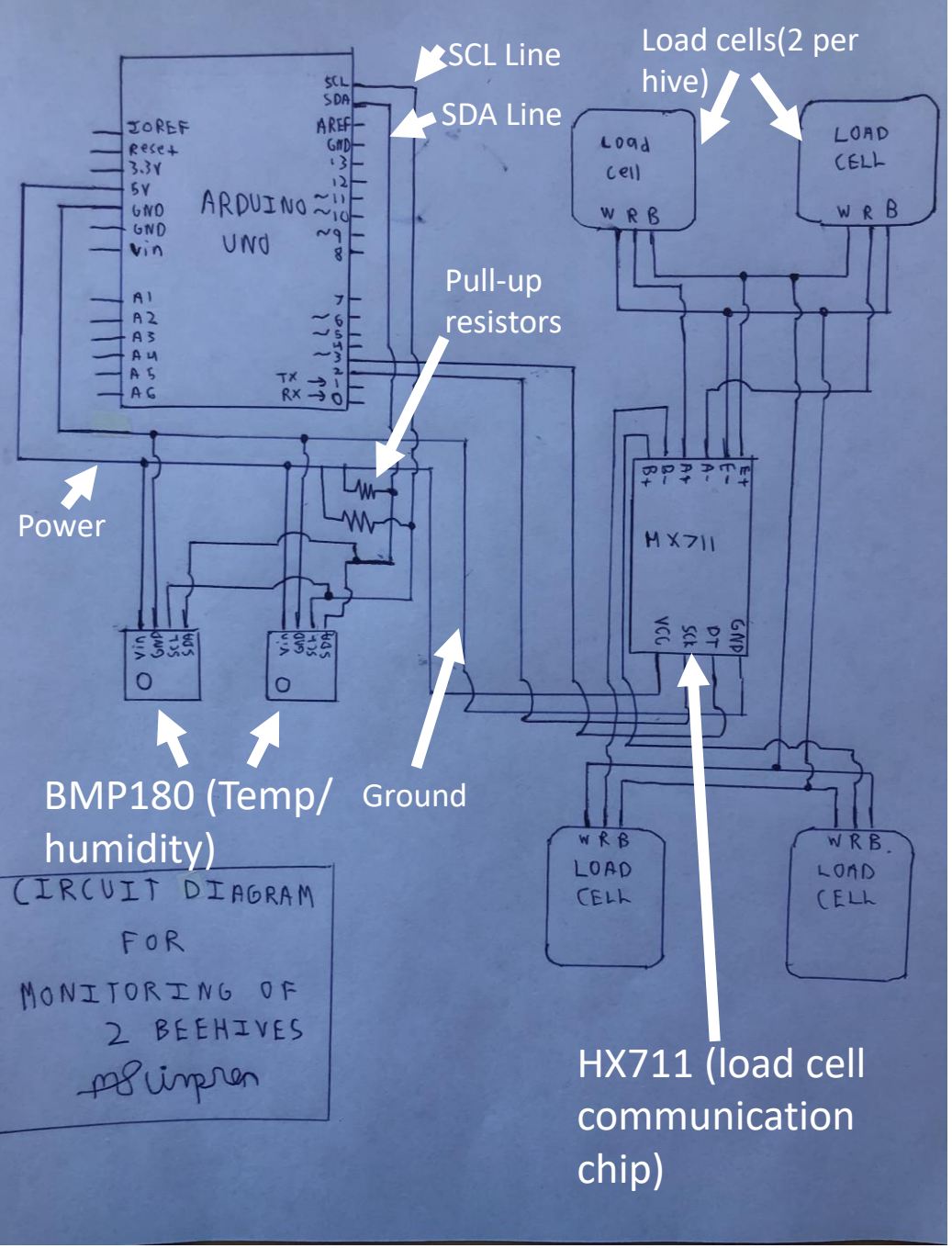


Figure 2: Circuit diagram showing sensor connections for 2 beehives, missing GSM shield for communication with server, power sources, and SD-card reader

- Function:
  - To achieve required cost goal each Arduino will be utilized over multiple hives
  - Figure 2 shows connections required for 2 hives for:
    - temperature/humidity sensors BMP180's
    - weighing system including HX711 communication chips and load cells
  - Temperature/humidity sensors connected through the I2C bus on the Arduino allowing multiple sensors and requiring two pull-up resistors (values dependent on number of components linked to Arduino) on the SCL and SDA lines
  - Requires more ideation for the inclusion of sufficient power source, SD-card reader, and communication with server.
- Goals:
  - Complete initial physical wiring prototype by the end of week 19
  - Connection capacity of at least 5 hives per Arduino
- Testing:
  - Figure 2 will be converted into physical circuitry utilizing preowned and purchased materials, then tested through code manipulation

Subsystem Designs – Weight Sensors & Base Plate

- Function:
  - The base plate inner width is the same as the beehives so it can fit a beehive and balance it over its 4 load cells
  - Each base plate has 4 load cells having a combined capacity of 200 kg or 441 lbs
  - The load cells are connected to the Arduino via the HX711 chip, the Arduino will then send the information via SMS to the server
- Goals:
  - Complete initial physical wiring prototype by the end of week 19
  - Test possible creep of load cells by week 20
- Testing:
  - Once Figure 2 is converted into physical circuitry, then Figure 3 will be tested through weighing various objects at similar weights to the beehives

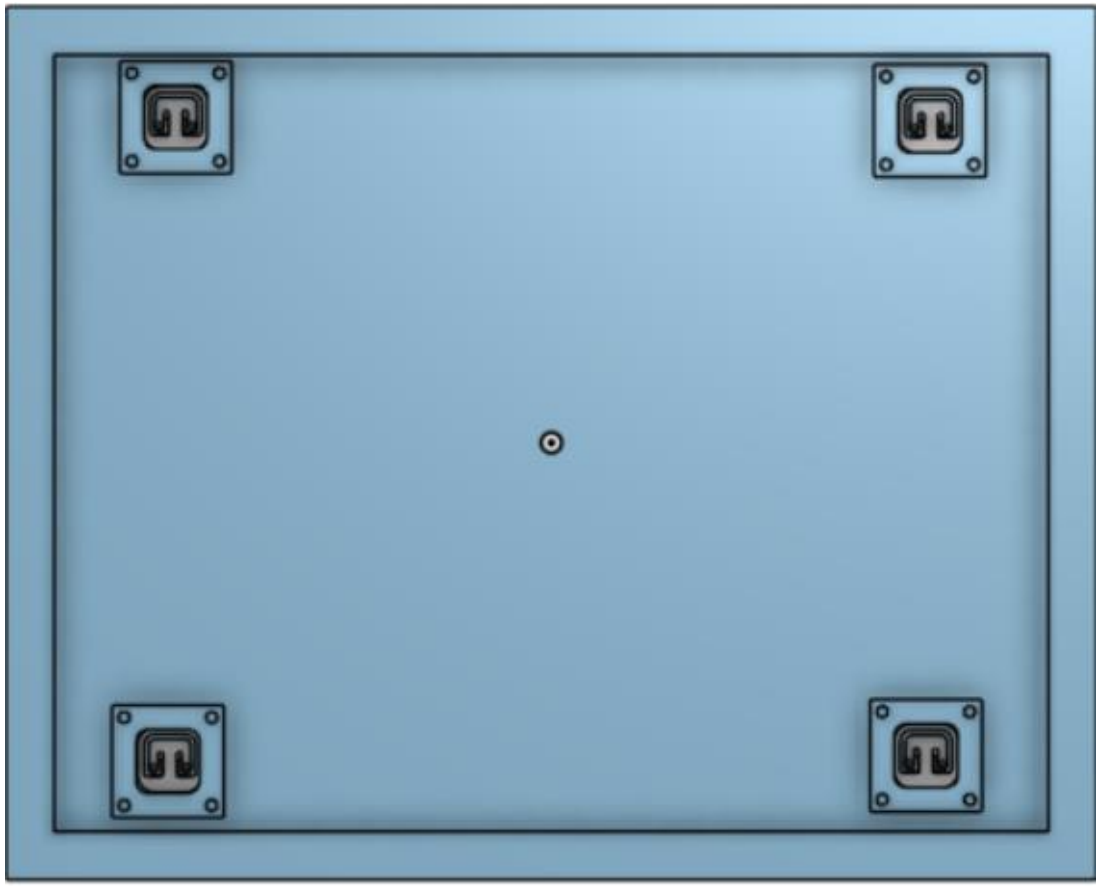


Figure 3: Prototype of base plate with load cells in place

Subsystem Designs – Server (backend)

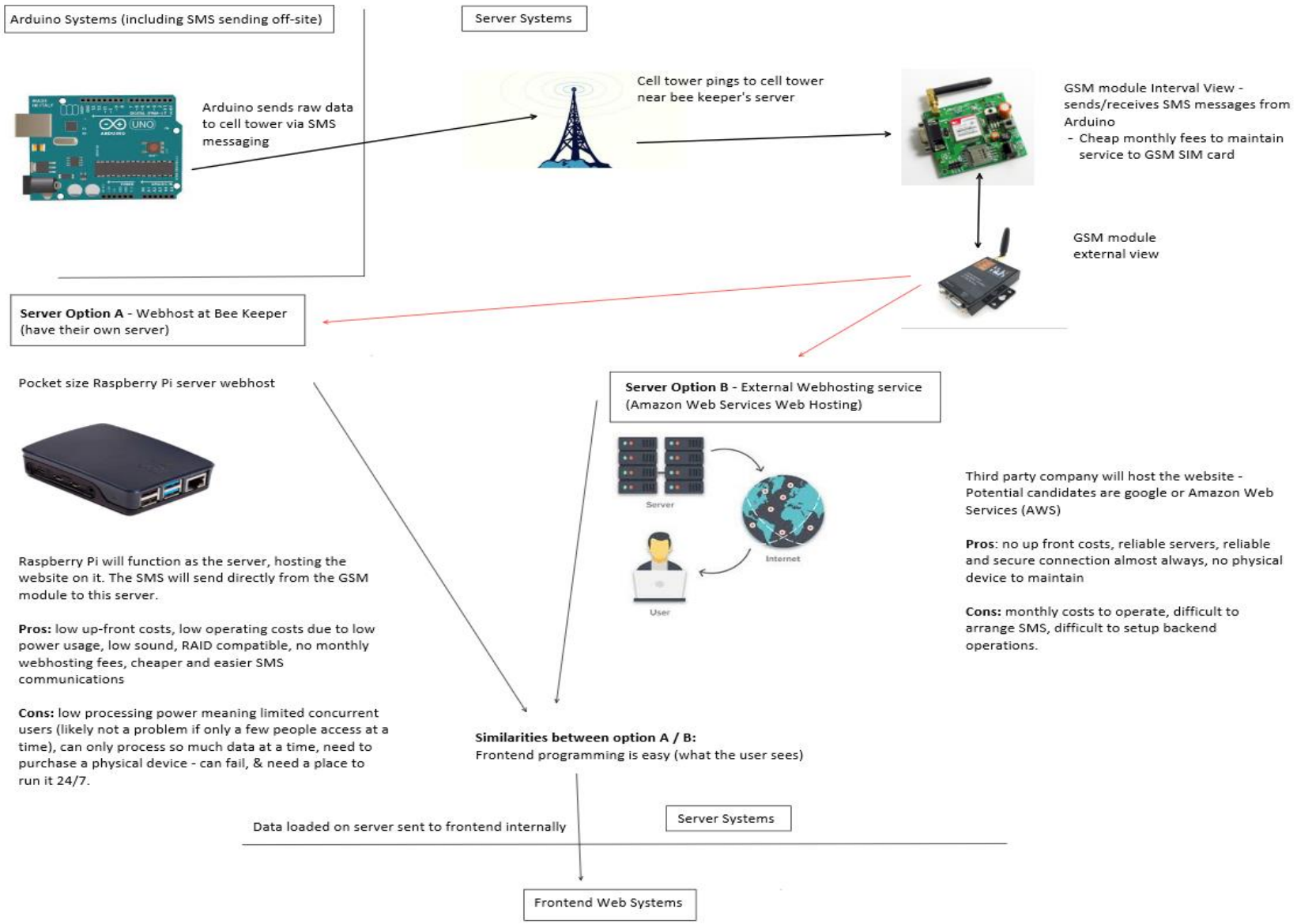


Figure 4: Flow diagram of server communication between Arduino and website

Subsystem Designs – Website Flow Diagram

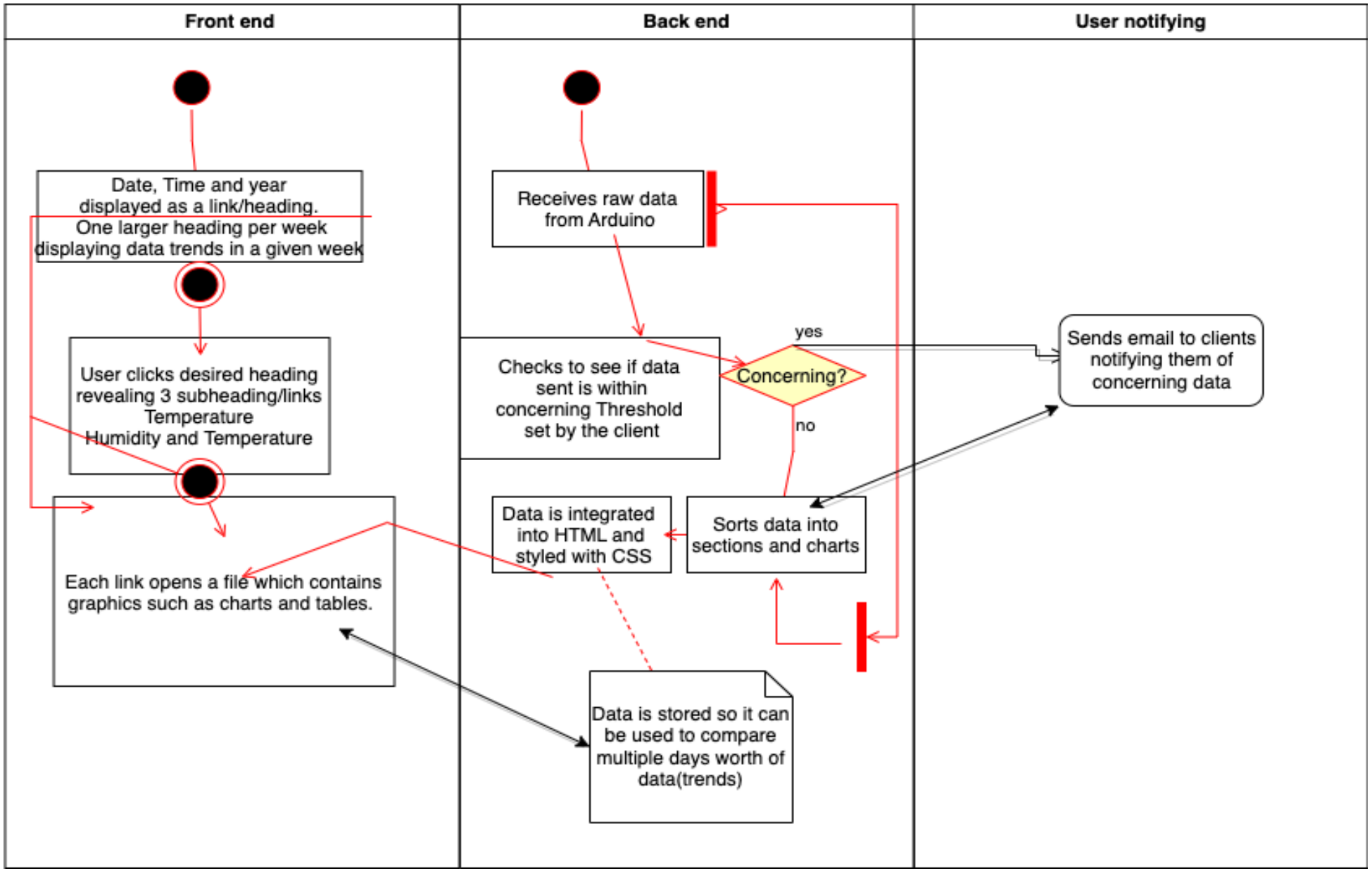


Figure 5: Flow/structure diagram for website front and back end

Subsystem Designs – Website (Frontend)

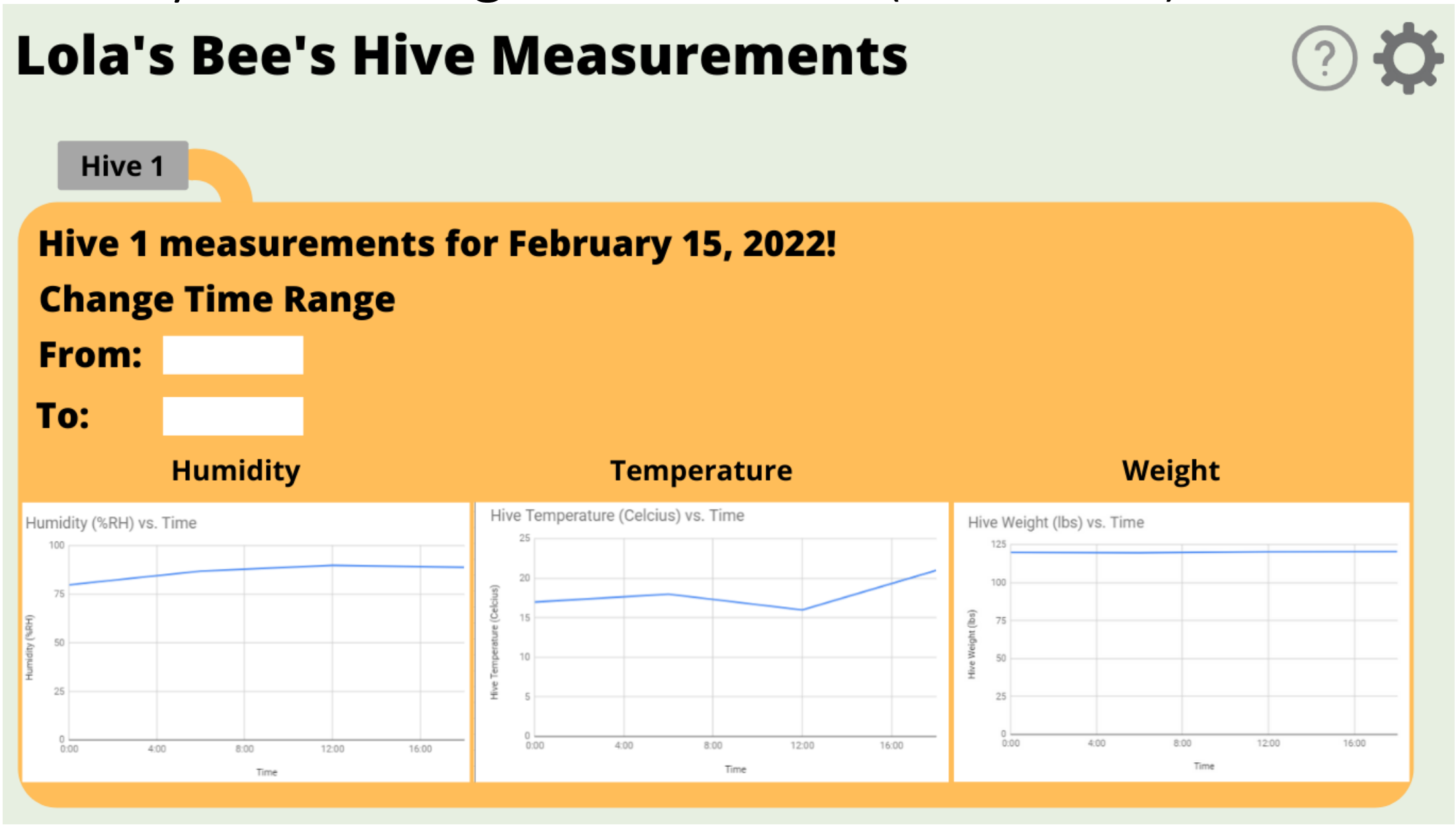


Figure 6: Screenshot of Current Website Prototype

Bill of Materials

Item	Link	Price	# hives Supported per purchase
Arduino Uno	Link	$42	5-8
Wireless transmitter	Link	$24.09	5+
Weight sensors	Link	$13	1
Temperature/ humidity sensor	Link	$10.26	5
Batteries	Link	$7	4
Arduino Housing	Link	$20	1 Arduino (5-8 hives)
Insulation (foam)	Link	$12.50	20+
tinfoil	Link	$5	20+
1-10 thousand ohms Resistors	TBD	TBD	5
SD-card reader	Link	$12	10
SD card	Link	$12.49	20+
Wires (generic)	Link	$11	20+
TOTAL PRICE		252.35	5

Tools & other resources:

- Soldering iron & filament
- Screws & screwdrivers
- Glue/zip-ties

Item	Initial price	Monthly costs	Link
SIM card	$20	$5 (with 1st month free)	Link

Current estimated cost per hive
(total costs/minimum estimated hives)

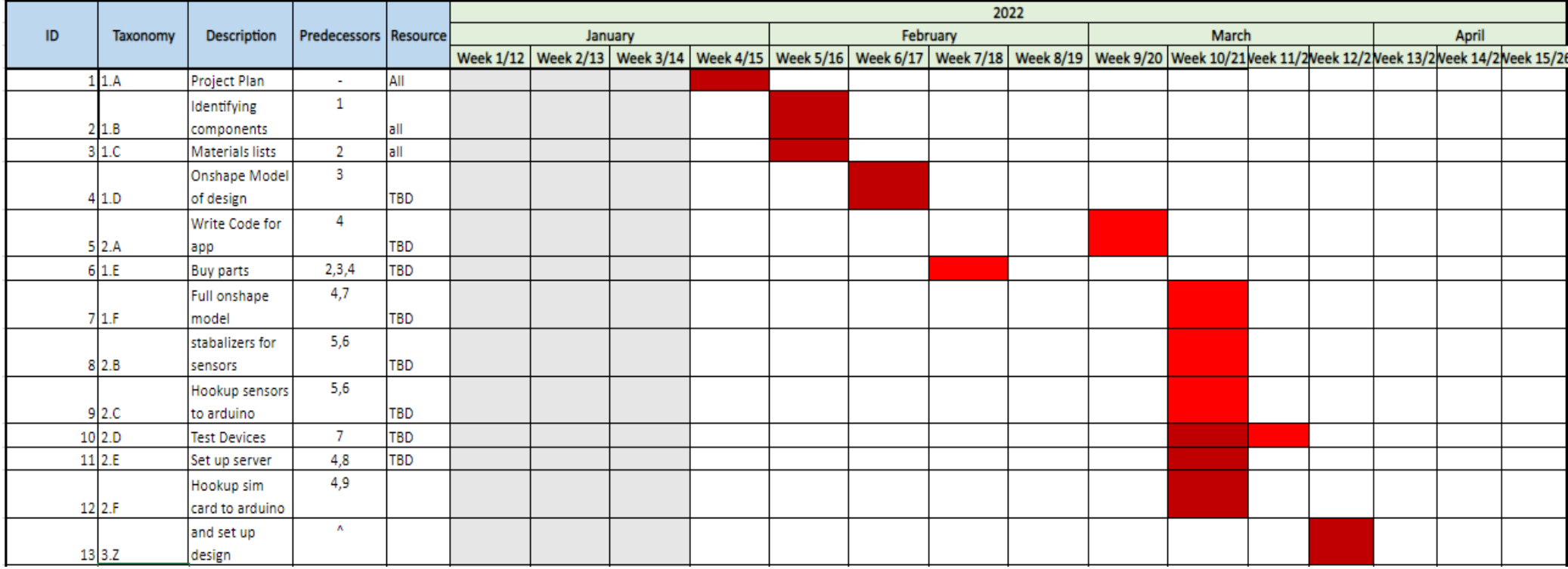
= $50.5

Expanded Pricing

# hives	Total price	Price per hive
1	$189.34	$189.34
5	$252.35	$50.5
10	$449.18	$44.92
20	**$886.86**	**$44.34**

Plan Schedule

ID	Taxonomy	Description	Predecessors	Resource
1	1.A	Project Plan	-	All
2	1.B	Identifying components	1	all
3	1.C	Materials lists	2	all
4	1.D	Onshape Model of design	3	TBD
5	2.A	Write Code for app	4	TBD
6	1.E	Buy parts	2,3,4	TBD
7	1.F	Full onshape model	4,7	TBD
8	2.B	stabalizers for sensors	5,6	TBD
9	2.C	Hookup sensors to arduino	5,6	TBD
10	2.D	Test Devices	7	TBD
11	2.E	Set up server	4,8	TBD
12	2.F	Hookup sim card to arduino	4,9	
13	3.Z	and set up design	^	



TASK DELAGATION	Physical Hardware	Software development	Server Development
Group Members Responsible	Mayank, Peter, Matthew	Nicolas, Jack, Luke	Luke, Nicolas
Components	Arduino, wiring, circuitry, waterproofing, housing electronics base plates for hives	Frontend of website, SMS communications, UML diagrams, transfer data to excel.	SMS communications, backend, webhosting, connection to Arduino Server construction

Questions?