IOWA STATE UNIVERSITY

SDMAY20-53:
Smart Backpack Sprayer

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Donald Laraquente (API Research Engineer)
Shuangquan Li (iOS Engineer)

Clients: Tim Andersen & Taylor Greiner

Advisor: Dr. Daji Qiao

http://sdmay20-53.sd.ece.iastate.edu/

Project Vision

- Create a smart backpack sprayer for different uses
  - Small scale agricultural operations
  - City use for sanitizing sidewalks or parks
- Display data to user
  - Increase efficiency of spraying
  - Record of previous applications
- Impacts to User
  - Minimize excess spraying
  - Minimize spraying costs
  - Ensure full coverage of spray on land

Conceptual Sketch

- Application that interfaces with backpack sprayer
- Clientele are farmers and city employees
- Unique in that nothing available to this scale

Functional Reqs (Hardware)

- The hardware shall
  - Use a flow sensor with accuracy to 10% of the duty cycle
  - Use a GPS sensor with accuracy to 3 meters
  - Use a compass Sensor with accuracy to 30 degrees
  - Have a battery life at least 3 hours.
  - Be mountable inside backpack sprayer
  - Package data in JSON format
  - Be able to send data using Bluetooth
- Data shall be collected in 1 second intervals
- Data collection shall be time-stamped with 24 hour time format

Non-Functional Reqs (Hardware)

- The system shall
  - Be water resistant
  - Be operable in temperatures between 0-40C
  - Be under 30 pounds
  - Be wearable on one's back

Functional Reqs (Software)

- The app shall
  - Display the row data
  - Display data in the map with a pin
  - Support multi-user usability
  - Support editing the type of chemicals
  - Sync data between cloud and local
  - Support offline data access

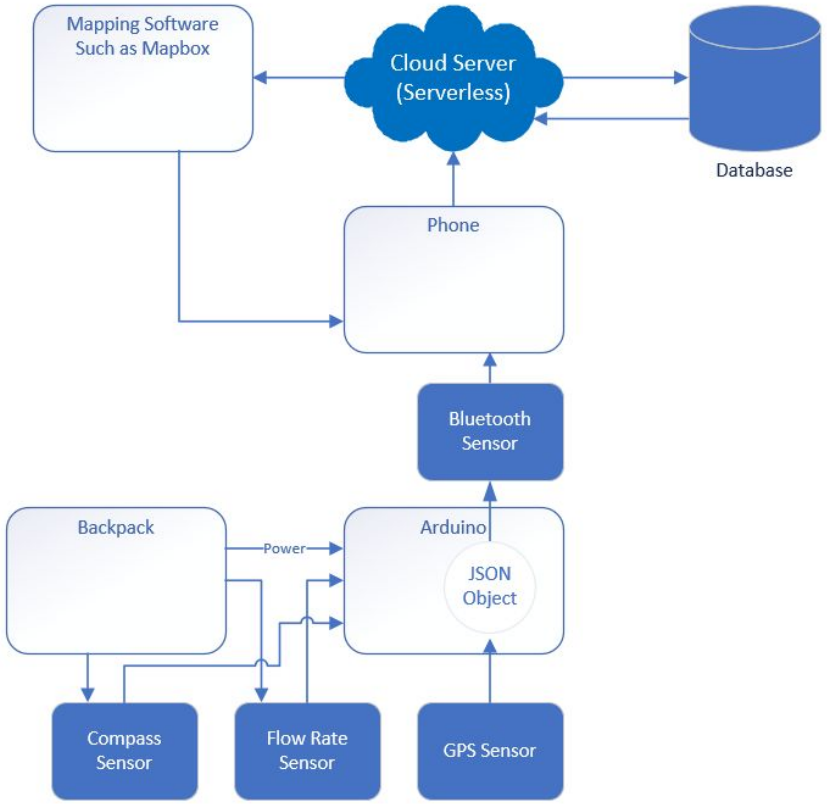
Non-Functional Reqs (Software)

- The code base shall easy to maintain
- Data shall only accessible to authorized user
- The system shall support large amount data transmission

Technical and Other Constraints

- Mobile platform - iOS
- Data format - JSON
- Close range communication - Bluetooth
- Low/off network connectability

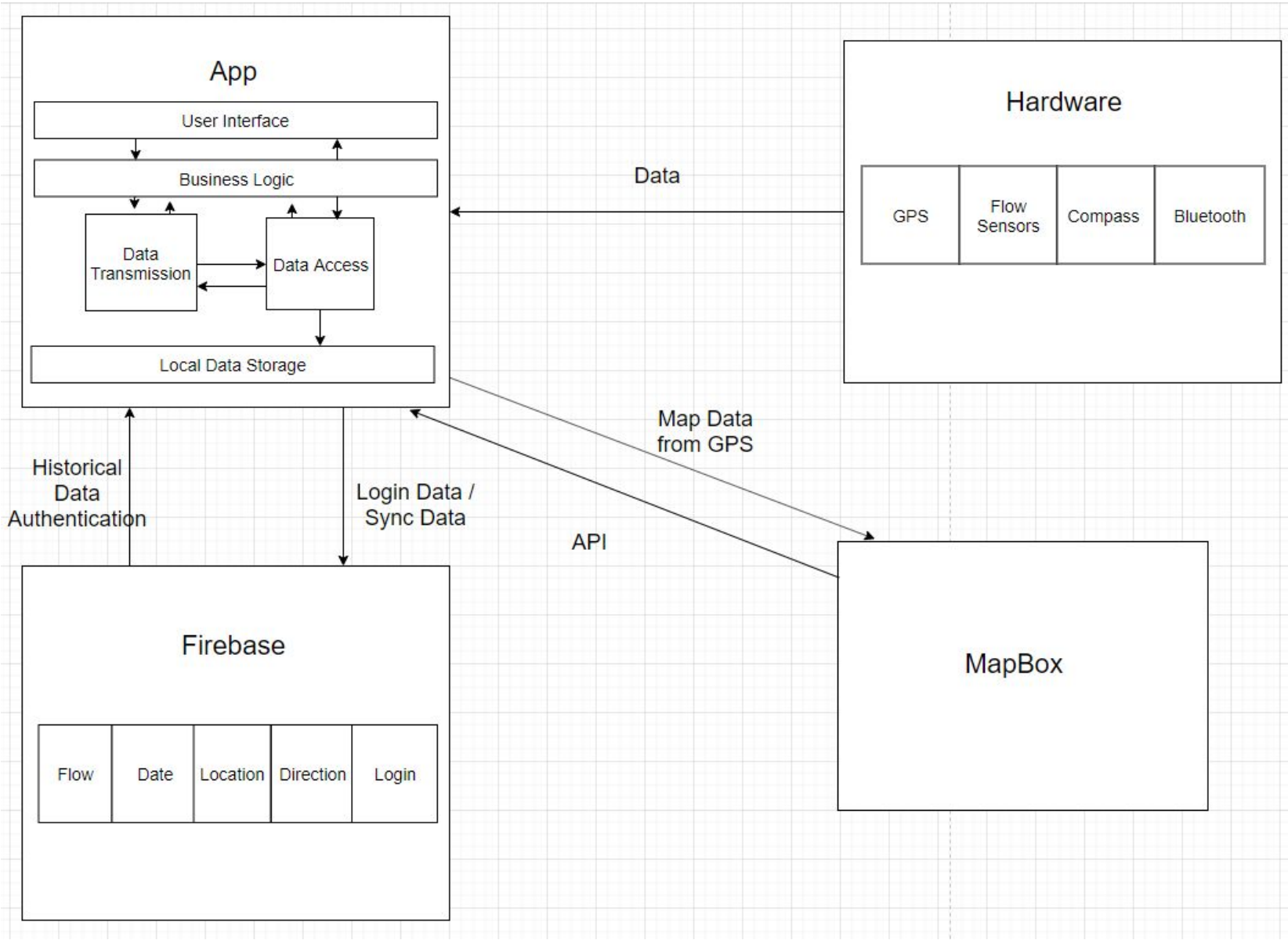
Conceptual Design Diagram



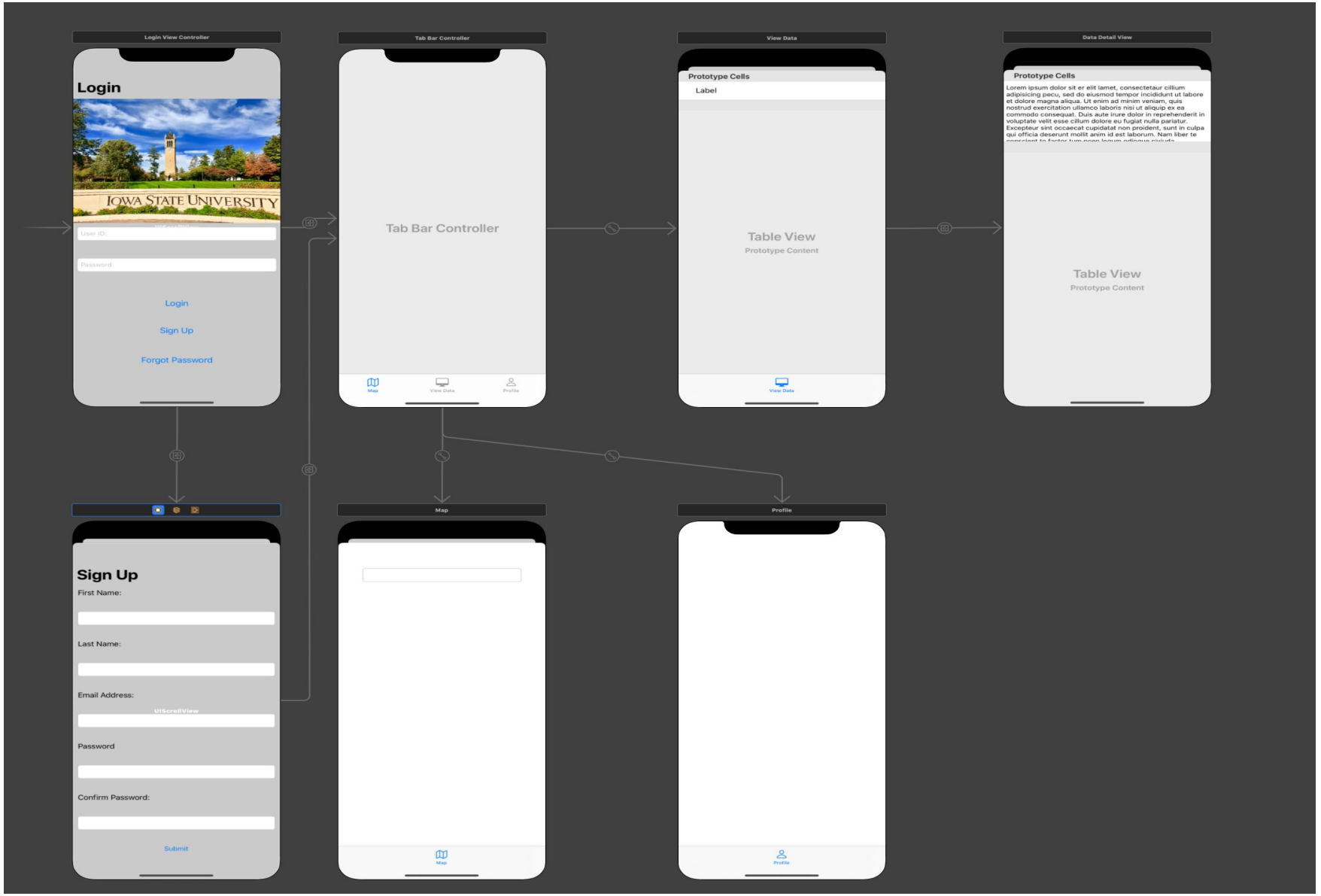
Project Plan

- Project Tasks
  - 3 sub-teams, each focused on one component
    - Hardware: David and Kevin
    - iOS Application: Madison and Shuangquan
    - API Integration: Sean and Donald
- Risk Management
  - Accuracy of sensors
    - Mitigation: Purchasing new hardware
  - Compatibility of sub-components
    - Mitigation: Early and often integration

Detailed Design - System Architecture Diagram



Detailed Design Interface Diagram

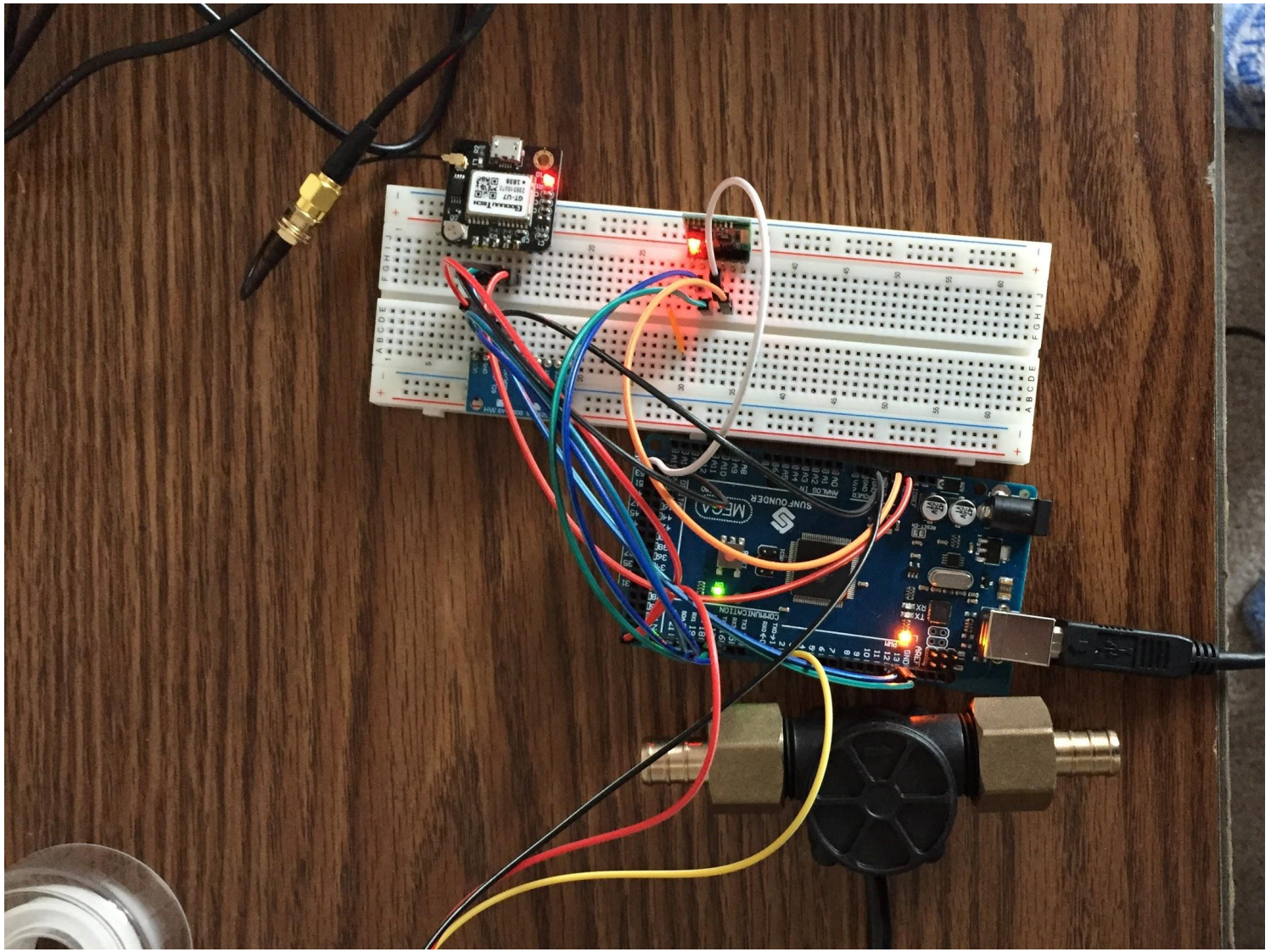


HW/SW Platforms

- Hardware Platforms
  - Arduino
    - TinyGPS++
    - ArduinoJSON
- Software Platforms
  - Firebase
  - Xcode
  - iOS
  - Mapbox
  - C++

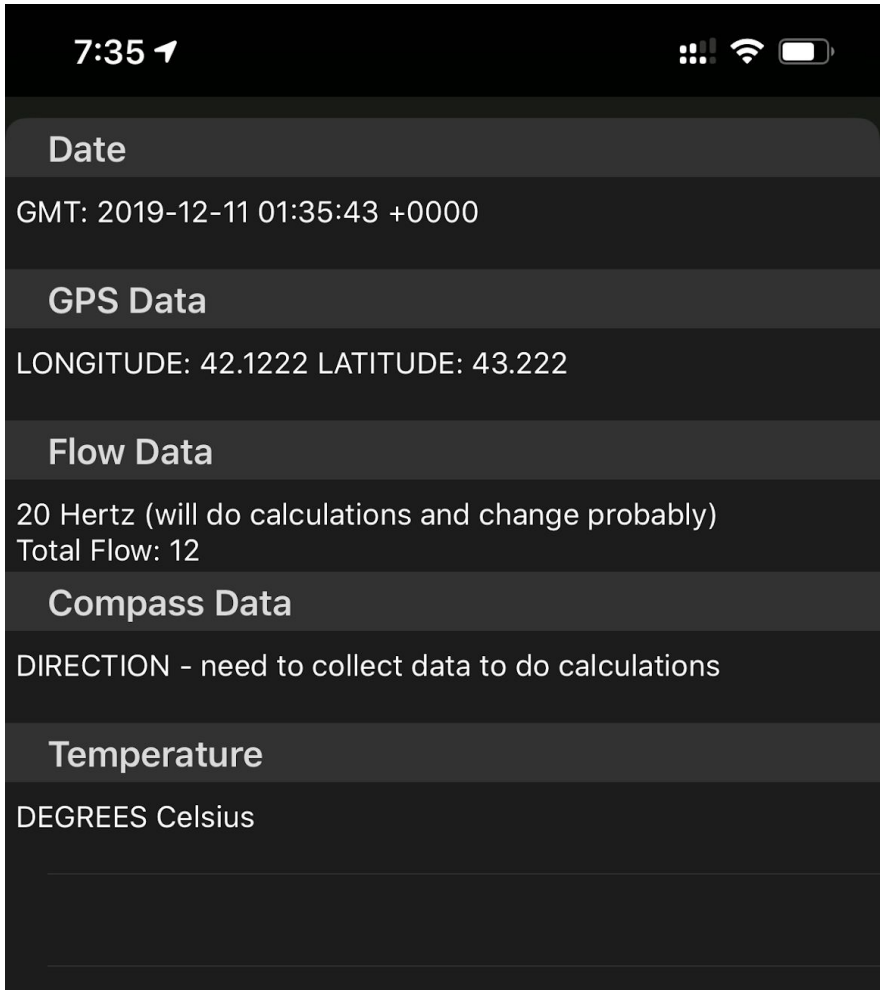
Prototype Implementations - Hardware

- Test hardware sensors individually
- Integrate together in single program
- Results
  - Collecting more data to ensure they are accurate
  - Bluetooth - work in progress
  - Package data to be sent

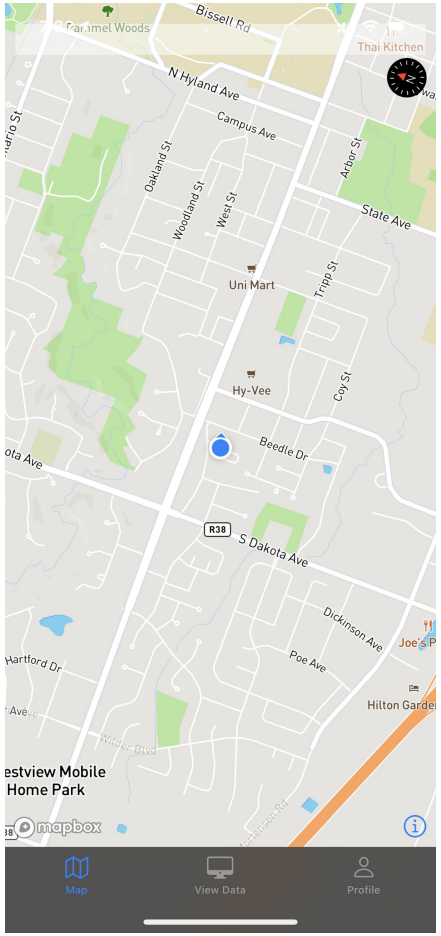


Prototype Implementations - iOS

- An app has been implemented
- Results
  - Displays raw data
  - Has multi-user login
  - Displays the map with current location
  - Connects to the cloud and transmit data



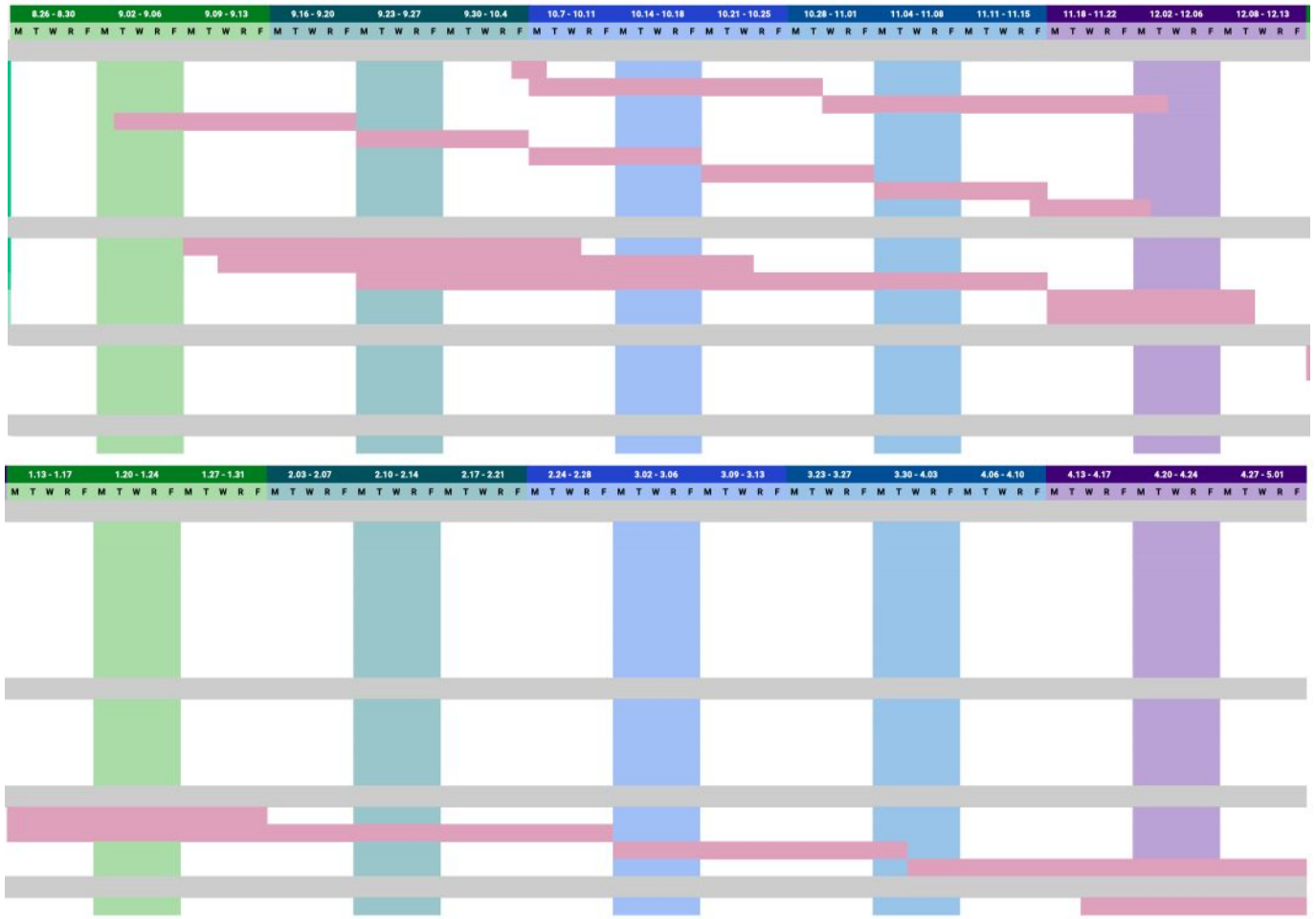
Prototype Implementations - API



- Created a project in Firebase
  - Users can login/register using their information
  - Users can also use their email to reset their password
- Created a project in Mapbox
  - This allows us to show the points we plot from the data received

Project Plan - Gantt Chart

TASK TITLE	START DATE	DUE DATE	DURATION	PCT OF TASK COMPLETE
Planning				
Design Document V1	10/4/2019	10/7/2019	3	100%
Design Document V2	10/7/2019	10/29/2019	22	100%
Design Document V3	10/30/2019	12/3/2019	33	100%
Weekly Report 1	9/2/2019	9/20/2019	18	100%
Weekly Report 2	9/21/2019	10/4/2019	13	100%
Weekly Report 3	10/7/2019	10/18/2019	11	100%
Weekly Report 4	10/21/2019	11/1/2019	10	100%
Weekly Report 5	11/4/2019	11/15/2019	11	100%
Weekly Report 6	11/18/2019	12/2/2019	14	100%
Fall Semester				
Hardware Delivery	9/9/2019	10/9/2019	30	100%
Hardware Assembly	9/11/2019	10/23/2019	42	100%
Software Development	9/23/2019	11/15/2019	52	90%
Software Prototyping	11/18/2019	12/9/2019	21	50%
Hardware Prototyping	11/18/2019	12/9/2019	21	50%
Spring Semester				
Receive Final Hardware	1/13/2020	1/31/2020	18	0%
Prototype Testing 1	1/13/2020	2/28/2020	45	0%
Prototype Testing 2	3/2/2020	3/31/2020	29	0%
Prototype Testing 3	4/1/2020	5/1/2020	30	0%
Finalization				
Prepare Final Presentation	4/15/2020	5/1/2020	16	0%



Project Plan – Milestones

- Hardware Delivery - Oct 9, 2019 - Completed
- Assembling Hardware - Oct 23, 2019 - Completed
- Software Completion - Nov 16, 2019 - Completed
- Integration - Dec 2, 2019 - In Progress
- Prototype for Software and Hardware - Due Dec 09, 2019 - In Progress
- Prototype v1- Due Feb 28, 2020
- Prototype v2 - Due March 31, 2020
- Final Prototype - Due May 7, 2020

Test Plan

- How is testing performed?
  - Simulator - iOS 13
  - Real device - iPhones
- Component/Unit testing
  - Testing each methods
  - Testing the modules of the hardware - flow sensors, GPS sensors
- Interface/integration testing
  - Testing where top-level units are tested first and lower level units are tested step by step after that
- Acceptance testing
  - Testing all the listed requirement in the design document.

Conclusion

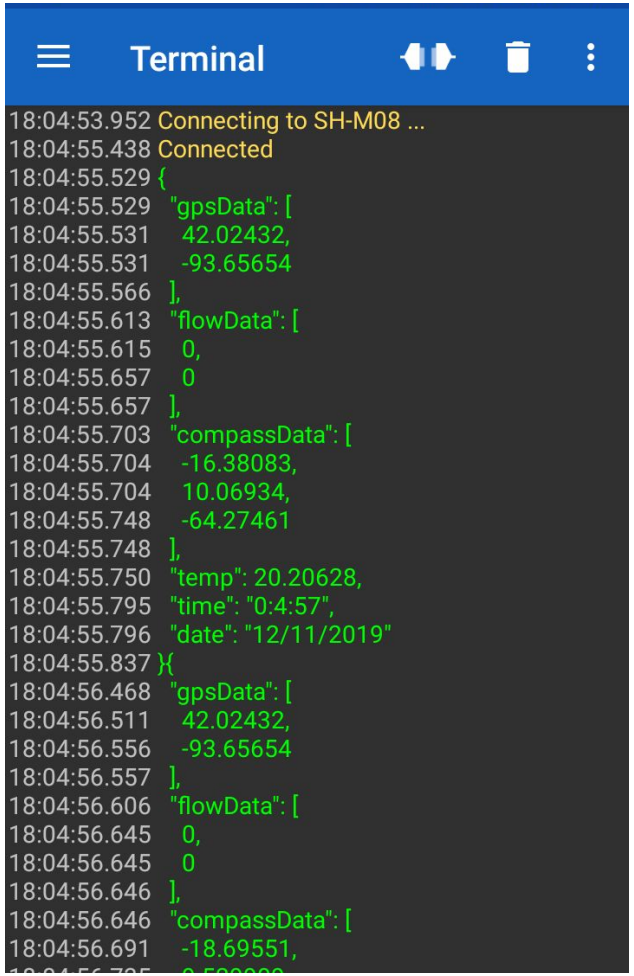
- Where are you in your schedule?
  - On track
  - We have completed enough of the basic design and documentation to allow the team to focus on software and hardware implementation
- Next semester's plans
  - Continue working on software and hardware design.
  - Complete several implementations related to bluetooth and sending information.

Questions?

Backup

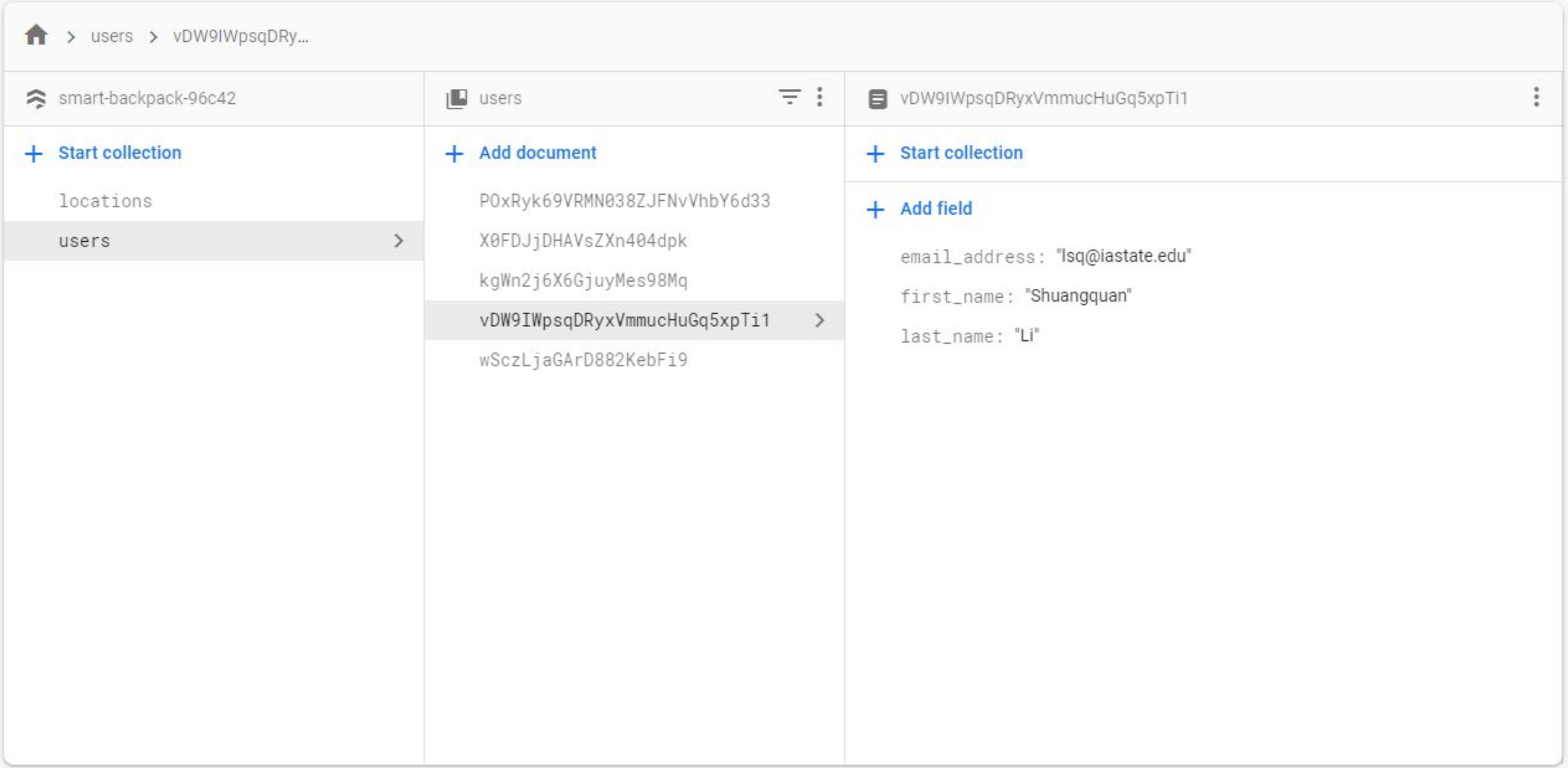
Flow Sensor Testing

JSON Example



JSON:

{
"gpsData": [
LONGITUDE,
LATITUDE
],
"flowData": [
FLOW (in Hertz) (will do calculations and change probably),
TOTAL FLOW
],
"compassData": [
DIRECTION - need to collect data to do calculations
],
"temp": DEGREES Celsius,
"time": TIME (in GMT) will need to change, was thinking on the phone,
"date": DATE (in GMT) will need to adjust, similar to time
}


users > vDW9IWpsqDRy...
smart-backpack-96c42
Start collection
locations
users
users
Add document
POxRyk69VRMN038ZJFNvVhbY6d33
X0FDJjDHAVsZXn404dpk
kgWn2j6X6GjuyMes98Mq
vDW9IWpsqDRyxVmmucHuGq5xpTi1
wSczLjaGArD882KebFi9
vDW9IWpsqDRyxVmmucHuGq5xpTi1
Start collection
Add field
email_address: "lsq@iastate.edu"
first_name: "Shuangquan"
last_name: "Li"
Cloud Firestore location: nam5 (us-central)