Team DataBit

Requirements Specification

Version 2

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Accepted as baseline requirements for the project:

Team Signature: _____ *Date:*_____

Client Signature: _____ *Date:*_____

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1 Introduction

Cardiovascular diseases (CVDs) are the leading cause of death globally. In the United States alone, nearly half of adults over 20 years of age have some form of cardiovascular disease, and approximately 655,000 people die from heart disease each year – around one in every four deaths nationally. Moreover, CVDs pose significant concerns in light of the coronavirus pandemic, as those who suffer from cardiovascular disease are at an increased risk of severe illness and death from COVID-19. Lifestyle changes, such as engaging in physical activity and getting enough sleep, are often the best way to prevent and treat cardiovascular diseases, so being able to monitor such behaviors in some way is an important part of addressing the problem at large.

More research is needed to better understand the relationship between lifestyle changes and their impact on disease risk/outcomes. To that end, researchers require a way to efficiently maintain and collect exertion and movement data from large numbers of patients. One approach is to employ wearable activity tracking monitors that can analyze physical activity and sleep behaviors throughout the day. Researchers can then conduct fitness and sleep studies and, in analyzing data collected from such devices, may aid their communities by taking action with the knowledge they extract- publishing findings, attempting their own interventions, or helping to conceive of new innovative solutions.

Often, devices such as Actigraphs™ are used in clinical settings to capture and record physical activity. These are small wearable devices that go on a person's wrist, much like a watch, and that monitor rest and activity cycles. However, Actigraph devices are expensive (around $250 per device), difficult to use, and incapable of storing much data over long periods of time, which makes them unwieldy for the purposes of long-term study with a large number of participants. Our project sponsor, Dr. Kyle Winfree, is a researcher who is interested in the utility and accessibility of Fitbits: a cheap and highly usable consumer version of an activity monitor as a potential alternative to Actigraphs in exercise and movement studies. As the leader of the Wearable Informatics Lab at Northern Arizona University – whose primary interest is in utilizing wearable technologies to measure and improve health care – one of his current concerns is the collection of wearable data from users. While Fitbit devices themselves provide a relatively inexpensive solution to data collection, it is not immediately obvious that they could be useful for large-scale studies. In particular, a major obstacle is collecting and accessing data collected by Fitbits.

[redacted]
near-real-time data access, or in communicating with and receiving feedback from the scientific community. These issues have prompted Dr. Winfree to devise the WearWare Project – a platform for evaluating wearable fitness tracking. This would allow researchers to create and manage studies, enroll participants, and access their Fitbit data for further analysis. A first prototype was developed and proved the basic concept, but previous versions of the project's database have suffered from poor performance and an inability to handle the sheer amount of data.

Our envisioned solution is to develop a new system from the ground up to create a powerful data management cornerstone as the backend of the WearWare concept. This will involve creating a powerful and flexible data collection, management, and delivery system that allows for the registration of studies, participants, and Fitbit devices, and communicates with the Fitbit API in order to download data in real-time. We will also be providing an API for future modules of the project in order to perform various operations on the data, as well as a basic development client that connects to this API for testing. In doing so, we will be providing Dr. Winfree and his lab – as well as potentially other researchers in the future – with an innovative and affordable product for use in various health studies.

In this document, we present the requirements that our software must meet in order for us to fulfill our obligations to our client, as elicited by our requirements acquisition process. We will describe the current problem that our client has in further detail, as well as our envisioned solution. We will then discuss the extensive, detailed requirements we have gathered for this project, in addition to some potential risks associated with our development of the application. Finally, we will give a tentative project execution plan with milestones as well as when we expect to meet them in the coming months.

2 Problem Statement

This project mainly centers around identifying problems from the previous WearWare system and improving upon them.

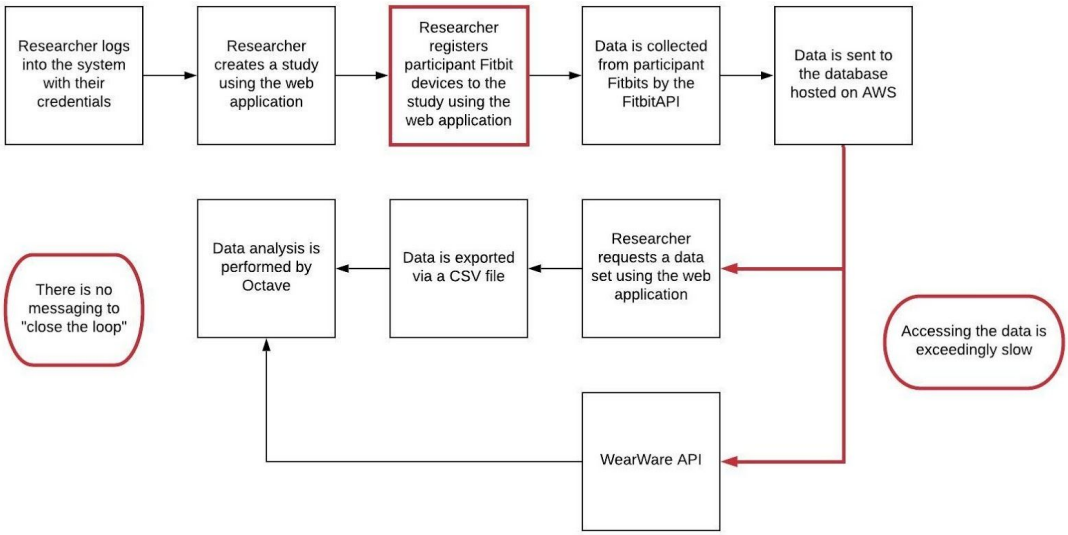

***Figure 1**: Workflow diagram illustrating the process flow of the current WearWare system. Current problem areas are highlighted in red.*

The figure above demonstrates the current workflow of the WearWare system as described here. As it stands, researchers can log into their account through the web interface and create new studies. In order to register Fitbits for a study, the researcher has to manually enroll participants: this involves scheduling an in-person appointment, and handing control of his own computer over to allow the participant to log in to their Fitbit account and sync it with the WearWare system. Once participants are registered, their activity and sleep data can start to be collected via the Fitbit API, and subsequently stored in a database on AWS. From there, the raw data can either be viewed using the WearWare API or extracted as a zipped CSV file by the researcher's request. The researcher can then perform data analysis using Octave requests in order to extrapolate meaningful information.

While the current process does demonstrate in a basic fashion that the WearWare system is viable for collecting and analyzing Fitbit data, at the moment it is inefficient, arduous, and error-prone. Specifically, deficiencies and missing capabilities are as follows:

- The current version was mainly designed to focus on the basic functionality; consequently, the UI was not a top consideration and usability suffers as a result. Although it is serviceable, having an unintuitive UI hampers easy use of the system by our non-technical researcher end-users.
- Manually registering each participant is inefficient. Not only is it an unusually time-consuming process, particularly when there are a large number of participants, but it is not secure for a researcher to physically hand over a device to the participant.

- Accessing the data is remarkably slow. It can take upwards of hours to export raw data.
- There is no messaging to "close the loop." If a participant is not wearing their Fitbit device or data is somehow not being collected from them, the researcher has no way of knowing and reaching out to a participant in order to correct such complications.

Our system must address these problems in order to be a feasible product that our client can effectively use.

3 Solution Vision

We will be redesigning the WearWare system to be more efficient and to provide functionality that is missing in the current version. In particular, our goal is to optimize performance such that database requests take a reasonable amount of time, as well as to streamline interactions between researchers and participants. Figure 2 below illustrates this.

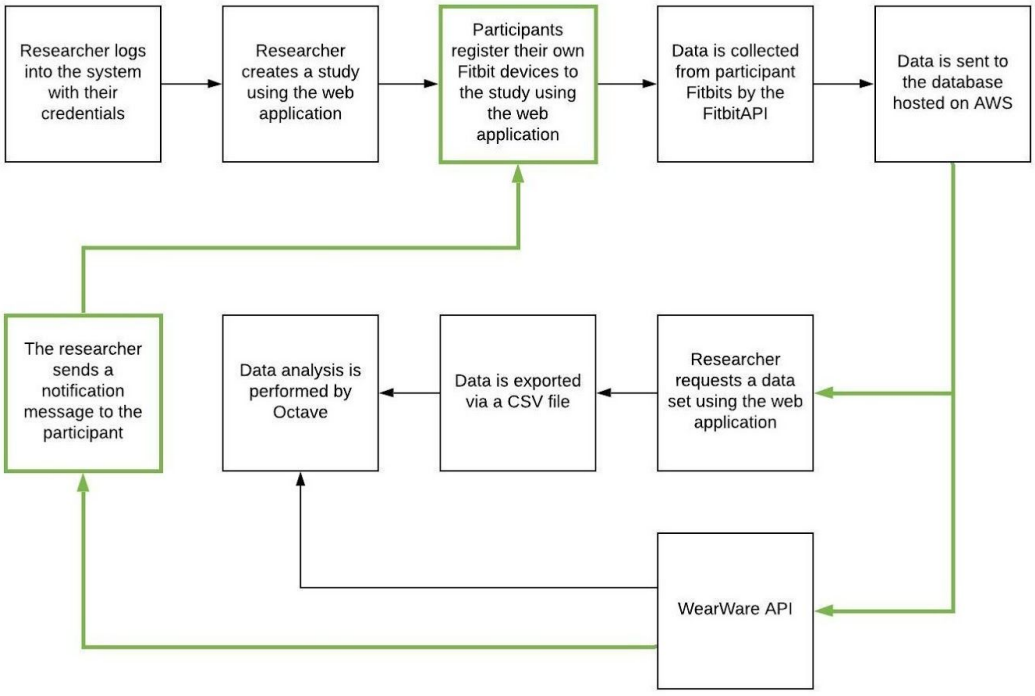

***Figure 2**: Workflow diagram demonstrating the process flow of our envisioned WearWare system. Problem areas that we intend to address are highlighted in green.*

Looking at Figure 2, the parts that are highlighted in green are the key changes we will be making to the WearWare system. The first change will be that participants will have the capability of enrolling themselves into a study, rather than scheduling an appointment with a researcher and having to meet in person with them to do. The second change will deal with the efficiency of communication between the database and the WearWare API; this will increase the speed at which data is queried. The final addition we will be making is a closed loop messaging system that will automatically send a message to a participant when the system detects they are not following the guidelines of the study they are enrolled in.

In sum, our new WearWare data management core aims to greatly improve efficiency and usability with several key features:

- Provide an easily navigable UI. We will be dedicating enough energy to designing the UI so that it is intuitive for researchers to use.
- Allow participants to enroll themselves in a study. This will be done by implementing a feature that sends a unique, one-time link to a sign up page to potential participants.
- Optimize performance of requests to the database. We will be prioritizing database design so that queries are more efficient. There will also be an export history, so repeat pulls can point to already existing files.
- Give researchers the ability to send messages to participants. If a researcher notices that a participant is not sending data for whatever reason, they will be able to notify the individual via email.

Although we are rebuilding the WearWare system from the ground up, it is unnecessary — and potentially even counter-intuitive — to make drastic changes to the workflow that our client is already accustomed to. Consequently, our approach from a design standpoint is to simply refine the areas that are unsatisfactory and to address any missing functionality.

4 Project Requirements

In this section, we will detail the complete requirements for the system described in our solution vision. These requirements will guide the process of building the web application and its API, and connecting it to the WearWare server containing the database hosted on AWS, which retrieves data from the Fitbit API. As a starting point, we begin by reviewing the domain-level requirements at the heart of our efforts. These requirements can be described as what the user — primarily, the researcher — needs from the envisioned web application and the database in order for it to fulfill its purpose.

We have identified the following as domain-level requirements:

1) Users with proper permissions will be able to create studies, enroll participants, and add researchers with access to the application. Researchers may be limited to only pulling data from a specific study, as opposed to the entire database. In addition, the permission to create and manage a study may be limited to head researchers as opposed to research assistants.
2) Users will be able to retrieve data from Fitbit. The data includes heart rate, activity level, and sleep analysis.
3) Users will have access to all stored participant data. Each study will have its own partitioned section in the overall database with a list of participants and their data points. Researchers will have access to this data from each study.
4) Users will be able to see data summary results. Data summaries will include tabular summaries from the database that can range in scope, from a single participant to hundreds or thousands. Researchers will be able to request these tabular summaries.
5) Users will be able to make requests from an Octave CLI. Octave will be integrated into the web application with our client's premade package of analysis functions.
6) Users will be able to receive alerts about participants and send messages in turn. Alerts may include which participant Fitbits are not recording new data, or if a participant has been unsubscribed from the study. Messages from researchers may include a reminder for a participant to wear their device if it is not sending data for an extended period.

These will serve as a baseline for defining our functional and performance requirements.

4.1 Functional Requirements

Functional requirements describe the detailed functions that the system must provide in order for the project to be considered complete. The following requirements demonstrate the necessary components of the WearWare system, as discussed with our client, Dr. Winfree.

The six domain-level requirements described previously in the last section can be expanded into a hierarchical system of functional requirements. These are the functions that the team must provide in order for the project to be considered complete and functional. Refer to the diagram shown below for a representation of how these requirements are broken down into more specific requirements.

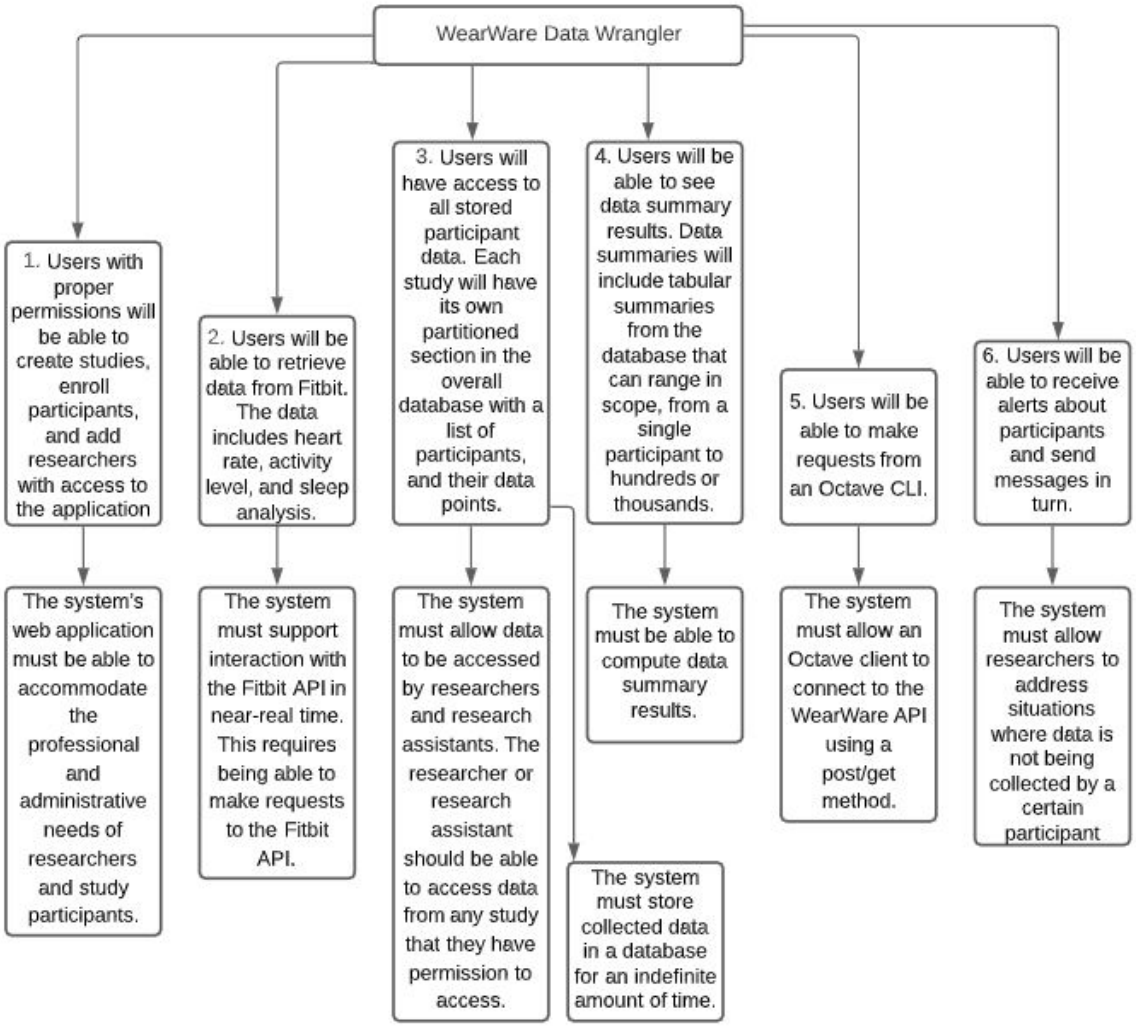

Figure 3*: Diagram demonstrating the process flow of breaking down domain level requirements into functional requirements*

We have also separated the functional requirements into more specific modules to better describe the roles they play. Those modules refer to the admin module, the data collection module, and the study management module. The following subsections will describe each of these in more detail.

4.1.1 Admin Module

The functional requirements that make up the admin module of the system describe functionality that deals with administrative duties such as creating studies and viewing any data related to specific studies.

1) The system's web application must be able to accommodate the professional and administrative needs of researchers and study participants.

a) The web application must show the participant, study information, and data selected for analysis.

i) Researchers must be able to view intraday heart rate data from individual participants.

ii) Researchers must be able to view intraday activity data from individual participants. Activity refers primarily to step count, distance walked, calories burned, and the physical activity level defined by Fitbit.

iii) Researchers must be able to view intraday sleep data from individual participants. This data refers to the time spent in specific stages of the sleep cycle and quality of sleep, as gathered by the user's FitBit.

b) Researcher end-users must be able to select and export collected data for individual studies as zipped CSV files.

c) The web application must display graphical representation of data segments.

i) Daily averages of heart rate, activity, and sleep data will be represented to properly authorized researchers..

d) The web application must support study creation and management.

i) Researchers must be able to set up studies.

(1) Researchers must be able to enroll a Fitbit device into a study.

(2) Researchers must be able to unenroll participants from a study.

(3) The original creator of a study must be able to give "researcher" permissions to other authorized users. These permissions include changing information related to a study such as its description and title and adding / deleting participants.

ii) Individuals with their own Fitbit device must be able to enroll themselves into a study through the use of a unique link.

(1) Fitbit pairing must be able to happen remotely rather than from within the client's lab.

2) The system must allow data to be accessed by researchers and research assistants. The researcher or research assistant should be able to access data from any study that they have permission to access.

a) The researcher must be able to access specific participant data.

i) Researchers must have access to metadata related to a specific participant. This includes device information such as subscriber ID, device model, and last known activity.

ii) Researchers must have access to raw data related to a specific participant. This includes heart rate, activity level, and sleep analysis.

iii) Researchers must have access to a participant's contact information.

b) The researcher must be able to access all participant data in a study. For each participant, the system must display the following:

i) An identifier, which should not refer to the participant's real name.

ii) The participant's email address, which will serve as their contact information.

iii) All studies that the individual participant is enrolled in.

iv) The participant's sex and gender.

v) The earliest device sync date.

c) The researcher must be able to access message history from a study.

4.1.2 Data Collection Module

WearWare is ultimately a data collection and analysis tool. Since WearWare's primary operations revolve around collection and extraction of data, the data collection module is essential. The administration module above will give researchers the tools to set up large studies, while the data collection module will enable them to retrieve data for analysis. The data collection module will need to be capable of the following functional requirements for it to be a complete product.

3) The system must support interaction with the Fitbit API in near-real time. This requires being able to make requests to the Fitbit API.

a) The system must be able to retrieve metadata concerning the participant's Fitbit device.

i) The system must be able to retrieve the subscriber ID - the unique ID of the subscription created by the API client application.

ii) The system must be able to retrieve the device model - the type of Fitbit device (Ionic, Versa, Ace, Charge….).

iii) The system must be able to retrieve the device version - which firmware update the Fitbit is using.

iv) The system must be able to retrieve device status - if the device is synced or not.

v) The system must be able to retrieve last logged activity - last activity the device owner manually logged into their Fitbit app.

b) The system must be able to retrieve raw data associated with individual participants in minute or sub-minute intervals as accessible from the Fitbit API. Intraday data refers to data collected within a single day. End of day summaries, which Fitbit provides, will not be accurate enough for scientific study.

i) The system must be able to retrieve intraday heart rate data from the Fitbit API. This is recorded at the sub-minute level as available.

ii) The system must be able to retrieve intraday activity data from the Fitbit API. This is recorded at the minute level as available.

iii) The system must be able to retrieve intraday sleep data from the Fitbit API. This is recorded in the event and summary format as available.

c) Requests made to the Fitbit API must be done in configurable time intervals. The data referred to in the following requirements are the heart rate, activity level, and sleep data from their Fitbit device.

i) The system must be able to automatically handle when a request times out. Timeouts may occur when a request is too large, or there is

a disruption in the connection between the Fitbit API and WearWare system.

ii) The system must be configurable to retrieve data from participant devices every minute.

iii) The system must be configurable to retrieve data from participant devices every hour.

iv) The system must be configurable to retrieve data from participant devices when requested from the researcher. Researchers should be able to pull data on-demand, or at scheduled intervals.

4) The system must store collected data in a database for an indefinite amount of time.

a) The system must store logistical and administrative information of all studies.

i) The system must store the title of each study.

ii) The system must store a 200 word description of each study.

iii) The system must store start time/date and stop time/date of each study.

iv) The system must store the web address of each study.

v) The system must store the contact information (email) of the primary researcher of each study.

vi) The system must store the contact information (email) of the participants in each study.

b) The system must store information related to participants, effectively pairing a participant to any studies that they are enrolled in.

i) The system must store the participants metadata retrieved from the Fitbit API. Metadata includes device information such as subscriber ID, device model, and last known activity.

ii) The system must store the participants raw data retrieved from the Fitbit API. Raw data includes heart rate, activity level, and sleep analysis.

c) The system must be able to handle errors that occur when data is inaccessible.

i) The database must be able to handle irregular data time intervals. Since Fitbits are not perfect, there will be times that heart rate data will be intermediate in its recording, and the database system should be able to handle irregular intervals.

ii) The database must be able to handle empty or incomplete data. Incomplete data will occur when a participant is not wearing their FitBit device, or if their device is failing to sync.

iii) The database must be able to backfill missing data when it becomes available on the Fitbit servers. Requests for data may not be successful if for example, the device is not charged. In these cases, a request when the device is next charged should be able to retrieve missing data.

4.1.3 Study Management Module

The functional requirements that make up the study management module of the system entails what the system can do for the researcher and what the researcher can do with the data found from FitBit API.

5) The system must be able to compute data summary results.

a) The system must be able to detect missing data and notify users of problems.

i) The system must detect if a device has not synced with the WearWare server.

(1) The system must notify a participant of syncing issues.

(2) The system must indicate to the researcher there are issues with device syncing.

ii) The system must be able to sort the participants of a study by the number of successful syncs. The researcher can easily see which participants are lacking data from FitBits.

b) The system must be able to extract tabular summaries of the data available.

i) The system must calculate the average device wear time in a two week period. Wear time is the amount of time the Fitbit was worn and

charged. E.g. A researcher could request a tabular summary of 30 particular participants for device wear time over a 2 week period.

ii) The system must calculate the average activity level of any requested number of participants. E.g. A researcher could request a tabular summary of 30 particular participants for their activity level over a 2 week period.

iii) The system must calculate the average heart rate of any requested number of participants. E.g. A researcher could request a tabular summary of 30 particular participants for their heart rate over a 2 week period.

iv) The system must calculate the averages of each sleep data point for any requested number of participants. Sleep data points consist of R.E.M sleep, light sleep, restless sleep, etc. Each of these points should be summarized for each participant, or possibly across participants.

c) Researchers must be able to create graphs from pre-designed data analysis tools on any segment of data chosen through the API.

6) The system must allow an Octave client to connect to the WearWare API using a post/get method. Researchers will be able to run their own data analysis tools on any segment of data chosen.

a) Researchers must be able to get a list of studies.

b) Researchers must be able to get a specified study's info.

c) Researchers must be able to get the specified study's participant list.

d) Researchers must be able to get the specified participant's info.

e) Researchers must be able to get data, including study data, participant data, the date range of the study, and any and all data fields specified. The date range is assumed to begin at 12:00 AM.

f) Researchers must be able to get message history [study, participant, date range specified].

7) The system must allow researchers to address situations where data is not being collected by a certain participant.

a) The researcher must be notified by the system, highlighting a participant red if that participant has not logged any data recently.

i) The researcher must be able to see the activity of a participant.

ii) The researcher must be able to see the device status of a participant.

iii) The researcher must be able to see how long the participant has gone without logging data.

b) The system will send an email notification to a participant if data hasn't been collected.

4.2 Performance Requirements

Performance requirements define how well the system performs certain functions under specific conditions. Examples are speed of response, throughput, execution time and storage capacity. The service levels comprising performance requirements are often based on supporting end-user tasks. One use case of our system will be that a researcher will open up the application, log in with their credentials, go to a study they are currently running, and run a specific query to extract a specific data set. There is a major bottleneck (a bottleneck refers to a component of a system which is unable to keep up and slows down the rest of the system) to the current system's performance which we aim to address in developing the performance requirements for the system.

The performance bottleneck we see in completing these steps on the current WearWare system is in the file export time. At the moment, it takes over an hour to return a file containing the data related for a few participants, and the entire system even times out in cases where there are 40+ participants and multiple weeks worth of data. The longest time our system should take to successfully export a CSV file containing the data related to their query to a researcher should be in the realm of seconds for smaller data sets, and five to ten minutes for larger data sets. The system should also have in place a utility that will alert the researcher if the data set they have requested is likely to make the system time out, and it will prompt them to ask for a smaller data set in that scenario.

A minor requirement of our system's performance deals with how easy it is for the application to navigate and use. Users of the current system, on average, take about an hour to figure out how to navigate and use the UI. This isn't necessarily a long time, but it certainly isn't ideal. As the current UI was built with just functionality in mind and not ease of use, we are optimistic that users of our version of WearWare will be able to feel comfortable with the system in half an hour, which would be 50% less time than before.

The other major performance requirement of our system deals with database capacity. The AWS server we will be using caps out at 16TB of storage. Dr. Winfree expects to be using around 20,000 participants maximum in a study. On average, each participant will be storing 5MB of data over the course of 200 days, or approximately 10MB over the course of a year. If a study is to last an entire five years, one participant would use around 50MB of storage capacity. For a five year study using the maximum number of participants, the database would need to be capable of storing 1TB of data. Since our system will be capable of storing 16TB, this will not at all be an issue, but it is something to keep in mind as researchers could theoretically perform studies using even more participants, if they so choose.

4.3 Environmental Requirements

Environmental requirements refer to things that can limit the bounds of a project. These limitations can be imposed by the client, hardware, or software compatibility. The environmental requirements the team has identified are as follows:

- Must implement Dr. Winfree's premade library of analytical functions in Octave. The system must be designed in a way that allows support for Octave and these code libraries.
- The Fitbit API must be used as the project relies on the use of Fitbit devices.
- The project is additionally constrained by its small budget. This budget will be entirely devoted to hosting the database through AWS which requires a monthly payment. It is an "on-demand" pricing model but is the most cost effective option.

The team has determined that these constraints should not impair our development process in any major way and will be simple to follow.

5 Potential Risks

In this section, we will focus on the potential risks that our software faces. Here, a risk describes something that presents a threat to the validity of our product and which we have no control over. In order to analyze potential risks, we discussed as a team and with our client what broad threats the WearWare system could face. We then deliberated over severity and probability, and considered the risks that would have the most significant impact on our system and were probable enough to happen. With this in mind, we have identified three main risk categories that could impact this project:

- Policy changes
- Obsolete technologies

- Adjusted costs

Risk	Risk Severity	Risk Probability	Mitigation
Fitbit API Access Policy Change	High	Low	Use alternate device & API
Fitbit Devices Become Obsolete	High	Low	Use alternative device & API
AWS Prices Change	Medium	Medium	Use alternative web hosting, or host advertisements on WW.
WW Competitor Prices Change	Low	Medium	Offer unique features

***Figure 4**: Risk and feasibility table that outlines the potential risks and their assumed severity, probability, and mitigation technique.*

In the following subsections, we will discuss each of these risks and explain how they would impact our project.

5.1 Fitbit API Access

If Fitbit were to terminate the ability for researchers to access the API, it would irrevocably impact the system because there would be no way to retrieve data from participant Fitbit devices. This would demand finding another suitable device to replace Fitbits; if they were to simply change the way researchers are able to access the API, it may alternatively warrant an overhaul of the WearWare system to make them compatible once again. Ultimately, we have little choice but to simply hope that the Fitbit API maintains its integrity so that our system can continue to make use of it. However, it isn't very likely that Fitbit would change their policy so drastically that it impacts technologies already

accessing their API, and even if this were to happen we could reconfigure WearWare to work with a multitude of other wearable fitness trackers.

5.2 Fitbit Devices

It would be similarly devastating if Fitbit as either a company or a product were to become obsolete. This would demand that we find an entirely new wearable device to use as an alternative, but there is no guarantee that one would be cheaply available and also allow researchers to request useful data from participants. Moreover, such alternatives may function in a significantly different way; for instance, if the sleep/activity data is dissimilar enough to what Fitbit provides, it may not be compatible with the WearWare system, which would demand another redesign. While we do not foresee this happening anytime soon, as Fitbit currently does not have any significant competitors that are similarly inexpensive, it is something to keep in mind for the future. We would be able to mitigate this risk in the same manner as the previous one, by making the system work with a different brand of wearable devices.

5.3 AWS Price

One of the WearWare system's main selling points is that it is cost-effective. If this no longer becomes true, then the entire purpose of our project is immediately undermined. Although it is unlikely, Amazon may change how much it costs to use their web hosting service through AWS. As it stands, AWS is a relatively cheap and cost-efficient method of cloud database hosting, but if they were to make this service more expensive then it might not be worth the cost for our client. The preferred price point of this project for hosting is less than or equal to $100 on a monthly basis. If AWS were to become significantly more expensive than this, then we would need to look into a different cloud hosting environment, although it might impact the performance of the system. We will also design the system in such a way that would allow it to be hosted on a local server in Dr. Winfree's lab located at NAU.

5.4 Competitor Price

Another threat to our system being relatively cheap is if competitor products such as [redacted] Our goal would be to

identify the most desirable features for researchers that are not addressed by our competition.

5.5 Feasibility

Overall, we are reasonably confident from our assessment that any substantial risks can be addressed. The most severe risks are improbable, while those that are more likely are also more readily solvable. In any event, we have outlined mitigation measures so that we can appropriately pivot if it becomes a necessity.

6 Project Plan

In this section, we will discuss our plan to carry out the project. Our main development milestones are as follows:

- **M1.** Create the web app and its API.
- **M2.** Develop the database for storing Fitbit data.
- **M3.** Produce a functional prototype.

M1 and M2 describe the key cornerstones of this project - the database and its interface. Of course, in order to appropriately store data, the system must first support study management, so the web application is our first priority. Once those features are in place, we can implement additional functionality such as data analysis and messaging in order to reach our third milestone, which would involve a functional prototype.

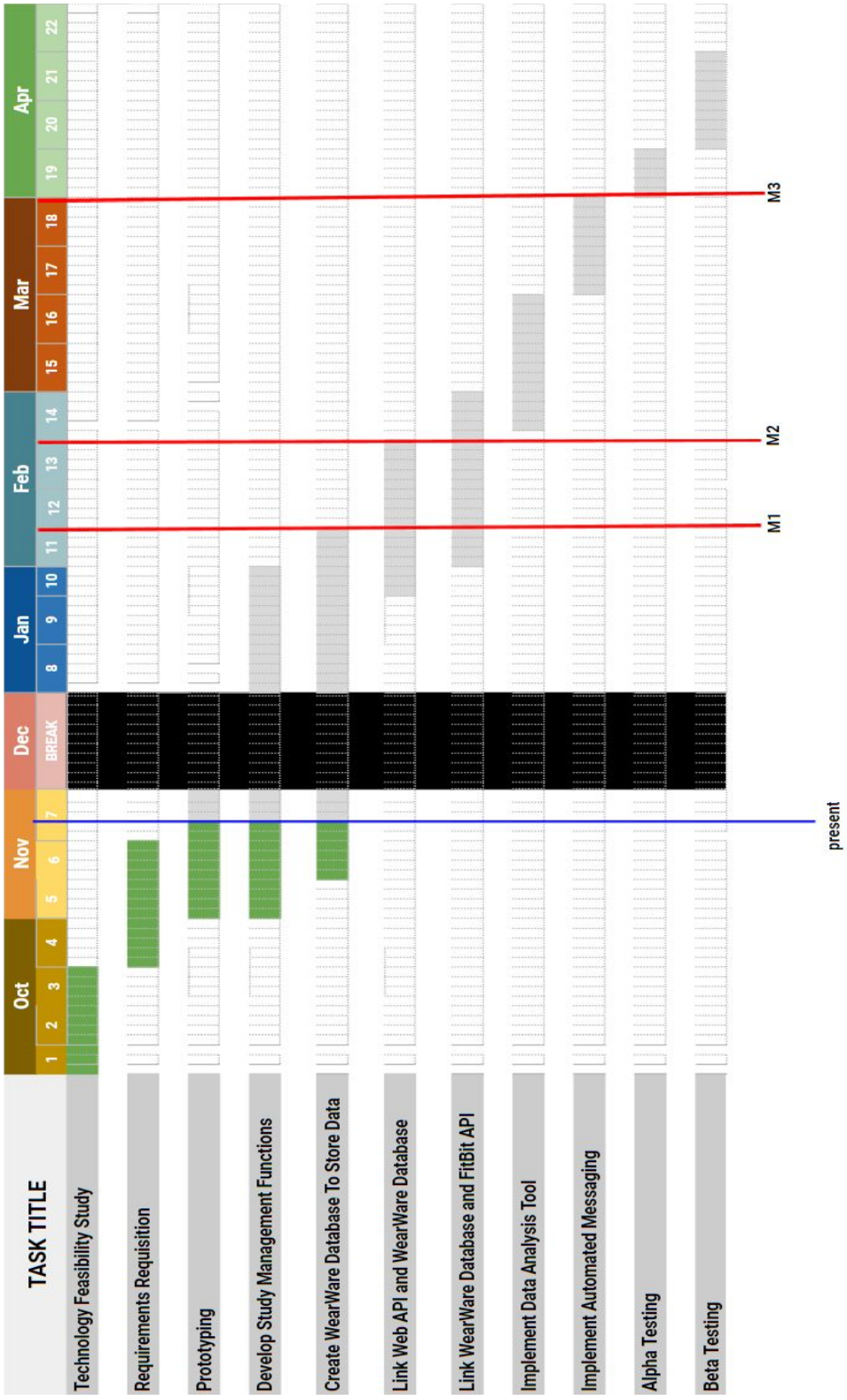

Figure 5*: Gantt chart of our tentative development schedule. Red lines show when we plan to have each milestone completed.*

As indicated in Figure 5, we are currently in the process of creating our technical demo prototype, which involves showing that our system's primary requirements of study and participant management and data storage are functional. It also demonstrates the capabilities of the messaging system we intend to use in the finished product.

Considering everything we need to do to design a functioning system, this is how we foresee our development schedule going. Our major goals for the foreseeable future are to create a web application which will allow researchers to interact with the system. Following that, we will develop the database which is meant to collect and store data from FitBit. We foresee this to be the most challenging milestone for us to overcome. After this is completed, we will then implement the use of Octave so researchers can analyze the data they have collected and the automated email messaging system. Finally, we will perform various rounds of testing to ensure that we have met expectations.

7 Conclusion

Given the prevalence of CVDs, which kill 655,000 people in the US each year, it is important for researchers to be able to conduct large scale health studies that can gauge the impact of physical activity and sleep on disease risk and outcomes. The WearWare system is intended to address this concern, by allowing researchers to utilize inexpensive wearable devices, namely Fitbits, and collect information such as:

- Heart rate, which can be tracked on a one-second interval.
- Activity level, which gives a range of a brisk walk to a full exercise routine.
- Sleep data, which provides in-depth analysis such as restless sleep, R.E.M. cycles, and light sleep.

While the current version of this system is quite flawed, we intend to redesign it so that it can serve as a robust and cost-effective study management platform. Optimization of the database system will be our priority change in the new system. Queries need to be much faster and responsive in order for WearWare to reach its full utility. In this document, we reviewed key problems with the current iteration of WearWare, detailed a solution, and used that to identify a comprehensive list of requirements for the system. Meanwhile, we acknowledged the potential risks to the project. Among those risks are:

- Fitbit API access policy changes
- Fitbits become obsolete.
- Competitive products become financially viable and more efficient

The chances of any of these risks happening are relatively low. Fitbit has had consistent researcher access for years and its market share of the wearable tech market has only

grown recently. [redacted] our primary competitor, is currently financially inaccessible for large studies. In the unlikely event that any of these risks come to fruition, we are confident that we can mitigate them by pivoting the product to new wearables, or further optimizing the system to bring costs down. Overall, given our discussions with our client, we are positive that we can create a product that meets these requirements and will ultimately be useful for researchers conducting large fitness and sleep studies.