MICHIGAN STATE UNIVERSITY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE 480 SENIOR DESIGN

Project Proposal
ArcelorMittal USA
Safety Equipment Bar Code Scanner

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Abstract

Design Team 3 has been asked to create a system to keep track of safety equipment on ArcelorMittal's buildings. To do this the team needs to build some systems. These systems will enable administrators to both monitor compliance standards on areas they are in charge of, and make sure that safety equipment is being properly checked and documented. Reports will be sent out periodically on the above to said administrators. On the user end, an Android application that uses a scanner will be created that will enable users to quickly answer questions on safety equipment standards. This project proposal is broken into the following parts:

1. The teams current understanding of the project.
2. Define the project in such a way that it will be easy to follow for developers that are maintaining the project for years to come.
3. Demonstrate that the team has internalized the design challenge faced.

Part I
Overview of Customer's Requirements

1 Background Research

There is background research that needs to be implemented to characterize primary hardware and software components that are needed for a successful project.

1.1 Assessing Customer Needs

To help define what this research needs to be on, we need to think of the customer's needs, and ponder a person, or group of people that would know the ultimate needs of a user. Team 3 has picked our sponsor, to be our primary point of contact for all things about the ”super user”. Our sponsor clearly defines what ArcelorMittal needs, and how the user will be interacting with our system. Jim has made it easy to contact him by both a personal telephone number, and emailing at any time of day. To assess our customers needs, we need to assess how much time we are saving the user by creating this new safety equipment system. In addition we can measure how much more accurate our system is over their previous design.

1.2 Design Constraints

With customer needs comes design constraints. One design constraint is time. We have been given one semester to work on this system. Another constraint is going to be cost. We have been given a budget of 500$ to create this system.

1.3 Feasibility of Designs

Criteria for feasibility of design includes the amount of skill asked to complete a design. As undergraduate computer engineers, we are not equipped to create systems that are very mechanical,

or that would include advanced computer programming principles (which would be better suited for graduate students in our field). The importance of creating a system that we know we have the skills to do so is very crucial to successful completion of the barcode scanner.
Criteria that can be used to rank feasible designs is going to be time. How much time does the proposed action take? How well is the proposed design documented? Solutions supporting simple, easy to read documentation is preferred by team 3.
Trade off studies that need be conducted to assess the above concerns are going to be speed of response time, and difficulty to move our software development environment to production.

1.4 Risks

Most risks are going to revolve around the security of our proposed system. This is solved by the implementation on ArcelorMittal's servers. ArcelorMittal has their own security team to ensure that the proposed system once moved to a production environment will be secure. In addition the data we are dealing with is not confidential.That being so, all code will be written in a secure manner, special attention will be paid to SQL queries, and SQL injections.

1.5 Overview of System Models

As the nature of this project is more software oriented then hardware, developing models for system senors, actuators, interfaces or other principle level system components are not a main concern of Team 3. So as a result, no validation is needed. Similarly, issues involving control processes are not a concern.
However, Operating Systems at different interconnections distances is a concern, as our sponsor has a special requirement of no WIFI at certain times when the application is operating. So that is one issue that has to be accomodated. Another issue is going to be the storage on the Nexus 7 tablets. A usual tablet holds up to about 16GB of memory, so we need to make sure that our application is well within that limit. In addition our software is limited to run on the hardware specfics of the Nexus 7, which are ULP GeForce graphics card, CPU is detailed as Quad Core. There is 1 GB of RAM.

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1.6 Developmental Strategy

Team three has picked a bottom up approach. We have chosen to implement the lower levels first. This will be easier for the team three because we can test the database communication first. In addition when we are trying to display data on the user interface, we have an implemented API to make that connection for testing. This is going to be easier then just hard coding data which will not be as efficient. We also set up the development enviornments for testing.

2 High Level Languages

2.1 Languages

As for compilers on the Back End most things will be written in the programming language Python, which does not have a compiler. For the email service, SMTP python libraries will be used, as well as a couple web framework libraries. The web framework Libraries are provided by Django, which is based off of Python.
Android Application Development is written in Java which does have a compiler. On the admin side, Jquery, Twitter's Bootstrap will be used for web development.
SOMEWHERE IN HERE REFER TO THE COMPARISIONS DOWN BELOW IN A DIFFERENT FIGURE

Part II
Technical

3 Project Definition

This team has been assigned an industry sponsored project from ArcelorMittal USA, who need a way to track their industrial safety equipment within their buildings. In order to build the specified system Team 3 will need to build three primary systems. The first being an Android application for operators to scan bar codes on safety locations and equipment. A web application to allow administrators to specify questions for specific pieces of safety equipment, and furthermore assign responsibility to workers. Finally, a server infrastructure will be created to ensure data is held properly and securely, host the web application, connect to the Android app, and generate reports.

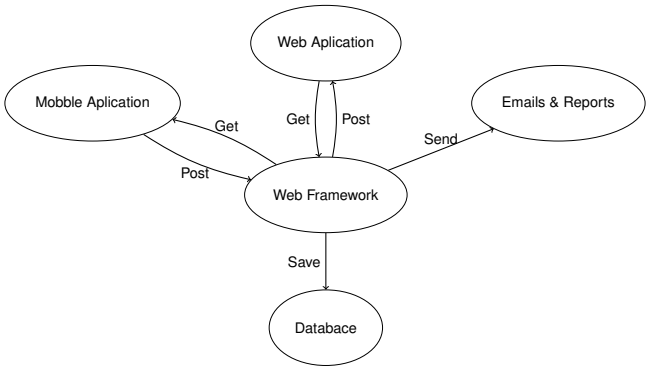

Figure 1: System Components

3.1 Scope

In order to guide the teams design project and ensure the project has limits of what the team will build, a project scope has been defined:

- **Mobile Application**
  - Off-line mode
  - Barcode scanning
  - Barcode based questions
- **Sever side Database and middle-ware**
  - Host:
    Web application
    Database API for mobile app
- **Emails & Reports**
  - Inform administrators of:
    Failing devices
    Delinquent inspectors
  - Inform inspectors of:
    Upcoming Inspections
    Missed Inspections
- **Web Application**
  - Add locations to the database
  - Add safety equipment types to the database
  - Create questions
  - Associate barcodes with:
    Locations
    Safety equipment
  - Associate locations with:
    Safety Equipment
    Questions
  - Associate safety equipment with
    Locations
    Questions
  - Add questions to reports
  - Create timetable for reports
  - Add recipient to reports

3.2 Function Definition

In order to justify the existence of items in Part 3.1 the team created a number of function definitions. These definitions were then consolidated into the FAST diagram in Figure 2 along with a more detailed description. The Primary function for the project is **Ensure Compliance** This is

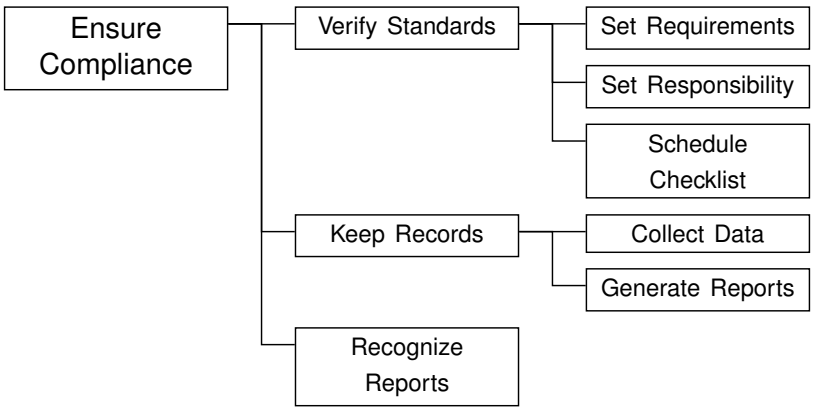

Figure 2: FAST Digram

the main goal of the system we have been commissioned to build. From our primary function are derived two secondary functions each having there own tertiary functions:

- Verify Standards:
  In order to Ensure Compliance with all pertinent safety regulations the system must be able to check the and verify that all the stranded are being upheld in the various locations and across the numerous safety devices.

- Keep Records:
  In order to ensure that all of the safety laws and regulations are followed we must keep records of all the locations which must have safety equipment present in a building, what safety equipment must be present, and how to verify that it is in working condition.
- Other

From the secondary function Keep Records we have derived:

- Generate Reports:
  In order to keep records and ensure that every location and item is in compliance the system must be able to generate reports on any set of data on which record are kept.

From the secondary function Verify Standers we have derived:

- Set Requirements:
  In order to verify standards the system must be able to set complacence requirements for each location and item which is being tracked by the system.
- Set Responsibility:
  The standards are being upheld a person must be assigned Responsibility for a number of locations and items within the system. Once this Responsibility is set the owner can be held accountably for there set of locations and items.
- Schedule Checklists:
  So that standards are verified checklists should be generated to show those who are responsible for items which items need to be checked to ensure compliance.

3.3 Use example

Here the team will use the data from the project description provided an example of how the team plans the how the system will be used.

4 Technical Design

4.1 Mobile Application

Design team 3 will build a mobile application for a tablet device which will allow a user to: download a database of safety equipment and locations to the mobile device to allow the user to operate with out access to the internet, scan bar codes of locations and safety devices to allow the user to answer a series of pass fail inspection questions, push question responses back to the database over the sponsor's internet. This last data push to the database will be completed when the user gets back to their desk, where there is WIFI available.

4.1.1 Mobile User Interface & Experience

Design Team 3 will create a user interface and experience (UI/UX) to guide the safety inspector through the process of an inspection. In Figure 3, the user is prompted to login so that the data relevant to that user can be synced to the mobile device. By doing so that the inspection results can be recorded under the correct employee's name.

If the user's device is connected to the internet, they will press the button labeled sync Figure 4 which will retrieve the inspection locations and safety device information pertinent to the user. Once the inspector reaches a location they will press the Scan Barcode Location button shown in Figure 4

Figure 3: Mock up of Start Screen

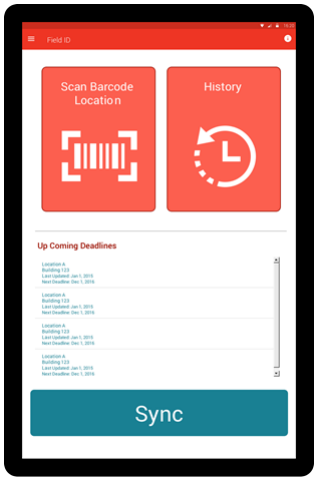

Figure 4: Mock up of splash screen

4.1.2 Barcode Scanning

4.1.3 Off-line Mode

4.2 Web Application

In order to allow the Administrators to add safety equipment and inspection questions to the database, assign ownership, and generate reports, Design Team 3 must build a web application. In order to do so the design team will use a web application development framework to build the features required quickly and robustly.
Based on the technical requirements and anticipated need Design Team 3 has devised the following criteria to judge possible choices of web frameworks:

- **Integrates With Sponsor IT**
  Design Team 3's sponsor ArcelorMittal USA uses a Microsoft Windows based infastructure for their internal IT. We must ensure our choice of framework is compatable in a Microsoft server environment.
- **Documentation**
  One of the most important parts of any software library is the documentation. If a developer is required to dig through source code to determine how a library works because there are no instructions explaining its implementation, the amount of time which will be required will increase exponentially and will result in code that is more prone to defects.
- **Ease Of use**
  The complexity of a framework can be quite large which can partially be determined by the framework's programming language. This requires Design Team 3 to determine how difficult standard tasks such as serving a web page, and dynamically creating content will be with each framework considered.
- **Learning curve**
- **Stack fullness**
- **Third party Ecosystem**

Then we chose from the plethora of existing frameworks seven which are cominly used in web app development to compare agents these requirements. The each criteria is marked on a log scale of ether 1,3, or 9 and displayed in Table 1.

- **Ruby on Rails**
  Ruby on Rails is a web framework also known as Rails built in the programming language Ruby.
- **Django**
  Django is a Python built framework and is one the most popular web frameworks. Django is well sported out of the box with numerous built in interfaces and a healthy ecosystem of free and open third-party add-ons to add interesting fetchers.
- **Play**
  Play is a Java Web framework. This framework as a large appeal for us as we will be writing our Android Application in Java, and there is a huge amount of support for the language which would be helpful
- **Express**
  Express is a Node.js Web application framework.
- **Laravel**
  Laravel Is a popular PHP based web framework

- **Revel**
  Revel is the go language web framework. As with many things in go there is one right way to do something and this is it.

- **TurboGears** Next generation python web framework. Taking cues from frameworks like Django and Rails this framework uses advanced python and other languages to build a web app.

	Django	Rails	Play	Laravel	Revel	Flask	TurboGears
Integrates With Sponsor IT	3	3	3	3	1	1	1
Documentation	9	3	3	3	9	3	3
Ease Of use	9	1	3	3	1	9	9
Learning curve	3	1	1	1	1	3	1
Stack fullness	9	9	9	9	9	1	9
Third party Ecosystem	9	9	9	9	3	1	3
Total	**42**	26	28	28	24	18	26

Table 1: Web Framework Solution Selection Matrix

4.3 Database

In order to see how items in the system are related to each other the team has created a entity relation diagram.

	SQLlite	Microsoft SQL	Oracle Database	IBM DB2	SAP SQl	MySQL	PostgreSQL	Firebird SQL	mongoDB	Hadoop
Integrates With Sponsor IT	3	9	9	9	3	9	3	3	1	1
Ease of Use	9	1	1	1	1	3	3	3	1	1
Documentation	9	3	3	1	1	3	1	1	3	1
Django Support	9	3	9	3	3	9	9	3	1	1
Fast insertion	1	3	3	3	3	3	3	3	9	9
Large Data sets	1	9	9	9	9	3	3	3	9	9
Enterprise Security	1	9	9	9	9	3	3	3	3	3
Team Expereance	9	1	1	1	1	3	1	1	3	1
The correct Price	9	9	1	1	1	9	9	9	9	9
Total	**51**	47	45	37	31	45	35	29	39	35

Table 2: Database Solution Selection Matrix

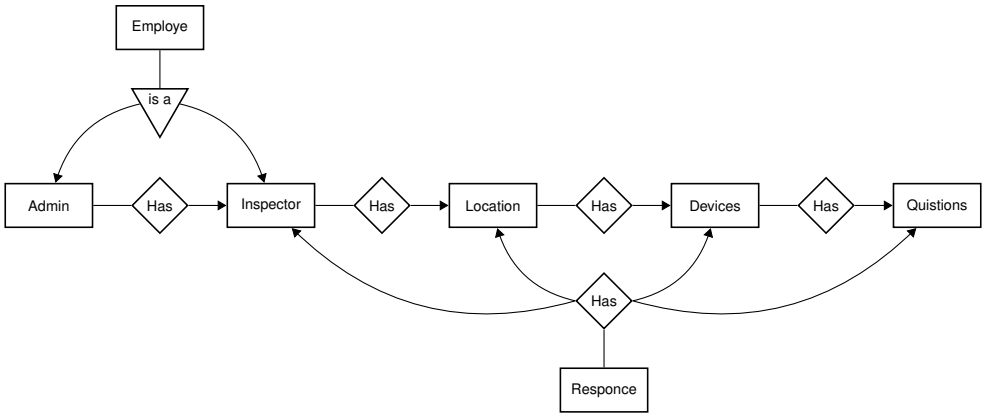

Figure 5: Database entity relations Diagram

Part III
Cost

The only cost incurred by the design team will be purchasing a Nexus 7 tablet. The tablet will be of the same model and year or similar to the sponsor's devices. Due to their security measures, we are unable to use one of the sponsor owns devices. To speed up the process of development, a group member has volunteered their Nexus 7 tablet to be used.

Part IV
Project Management

5 Scheduling

In order to better adapt to the complex requirements defined in Section 3, we have broken the tasks into four iterative cycles. Each cycle is planed to address a number of the design requirements which must be develop in or near parallel do to the highly interconnected nature of the individual subsystems.

5.1 Preliminary Set Up

In the first cycle the team pursues actions which move to the understanding of the finer details of the system it has been tasked to build. This cycle includes several instances of contact with the sponsor in order to both better understand the customers needs and build a relationship for ongoing communication. At the end of this cycle the team will deliver a project proposal to the faculty advisor and the project sponsor along with having verified that the most basic functionality of the database, web application, Android application and design mock-ups.

- **Meet with Sponsor:** (The Team)
  The team prepares questions and meets in person with the Jim Lang from ArcelorMittal. In order to better understand the needs defined in the project description. In this meeting the

project sponsor was asked to describe key features and furthermore, what a successfully project looked like.

- **Solidify Understanding of Project:** (The Team)
  In this task the Team meets to discuss what was learned in the meeting with the project sponsor previously. In order to layout the framework in which the team can build the requested system.

- **Additional Questions for Sponsor:** (The Team)
  After exhaustive discussion on the both the high level work flows and technical feasibility of the project the team will compose a set of questions to be electronically mailed to the project sponsor in order to clear up lingering discontinuity in the teams understanding of the system.

- **Set up Database:** (Alexandria & Ian)
  In this task two team members will decide on a framework for building the server side infrastructure for the system. This will include choosing and setting up the server operating system, choosing the main programing language to be used for building the sever infrastructure.

- **Hello World on Tablet:** (Kyle)
  In this task a team member will build a simple hello world program for style of android tablet indicated by the project sponsor. In building a hello world program for the tablet the team member will also choose a library for decoding bar codes using the tablet camera.

- **Draw Mock ups:** (Trevor)
  In this task a team member will draw the initial designs for the user experiences that will be had in the various user portals of the system so that the project sponsor can have an idea of what the user interface will be like and can give us insights that will help all aspects of the teams design.

- **Set up Web Page:** (Seth)
  In this task a team member will setup an initial front end for the administrator web sight. The team member will decide on a set of predefined web objects that can be used to build web applications which will best allows the team to build an effective web application front end.

- **Ask Clarifying questions for sponsor:** (The Team)
  After facing the initial feasibility challenges involved in the building the main subsystem of the project the team will compile the design report and a number of clarifying questions for the sponsor in order to further refine the teams initial design decisions.

5.2 Interconnectivity

In the Interconnectivity step design team 3 will focus on building and testing connections between the baseline system, setup in 5.1

- **Web speaks to Database:** (Seth)
  This step will consist of establishing a connection between the existing front-end of the admin website developed in 3.1 and the database that will allow the admin site to read from and write to the database. This functionality will be used for retrieving and modifying information regarding the whereabouts and inspection status of safety equipment.

- **Mobile speaks to Database:** (Kyle)
  This development task will require establishing a connection between the Android mobile application and the database. This will allow the mobile application to read information from the database to be displayed in the mobile application and to upload new inspection results from a local instance of the mobile application to the central database.

- **Demonstrate to Sponsor:** (The Team)
  In this phase, we will demonstrate to the sponsor, either in person or via video, the ability of the website and mobile application to both read and post information to one common, central database to be used for storing inspection results and safety equipment details.

- **Mock ups and Wire Frames:** (Trevor)
  The user interface of the mobile application and the admin website will be modified after receiving sponsor feedback regarding their current design to better suit the needs and wants of the customer.

5.3 Preliminary Application Development

- **Mobile App Development:** (Kyle)
  The implementation of the mobile application will be completed during this phase to produce a fully functioning prototype that is able to scan a barcode and pull information from the database related to that barcode. The application will then be able to upload inspection results of each item over a WIFI network to the central database.

- **Web App Development:** (Seth and Ally)
  The front-end and back-end of the admin website will be completed during this phase to produce an initial prototype. The admin website will be able to receive input from a user regarding barcode and their related specifications and post that information to the database to be used by the mobile application. This development is to be done in parallel with the mobile application.

- **Database Refinements:** (Ian and Ally)
  The database will be continually refined throughout the development of the admin website and mobile application to address any issues discovered during this development phase.

- **Feedback:** (The Team)
  The team will demonstrate the functioning prototype of both the mobile application and admin website to the sponsor and show how they integrate together to achieve a solution to the original problem. The team will discuss the sponsor's opinion regarding pros and cons of the implementation and create a plan for any modifications that the customer desires.

- **New Mock ups:** (Trevor)
  Modification to the user interface design will be made if the sponsor desires.

5.4 Secondary Application Development

- **Mobile App Development:** (Kyle)
  Any desired design modifications to the mobile application requested by the sponsor in 3.3 will be implemented and tested in this phase.

- **Web App Development:** (Seth and Ally)
  Any desired design modifications to the admin website requested by the sponsor in 3.3 will be implemented and tested in this phase.

- **Database Refinements:** (Ally)
  Any necessary database changes needed to accommodate modifications made to the mobile application or admin website will be implemented.

- **Make project shippable to sponsor:** (The Team)
  The mobile application will be compiled into an executable that can be uploaded on the sponsor's tablets. All passwords necessary to access the admin website will be given to the sponsor along with the source code for the website so that the website may be uploaded and hosted wherever the sponsor desires.

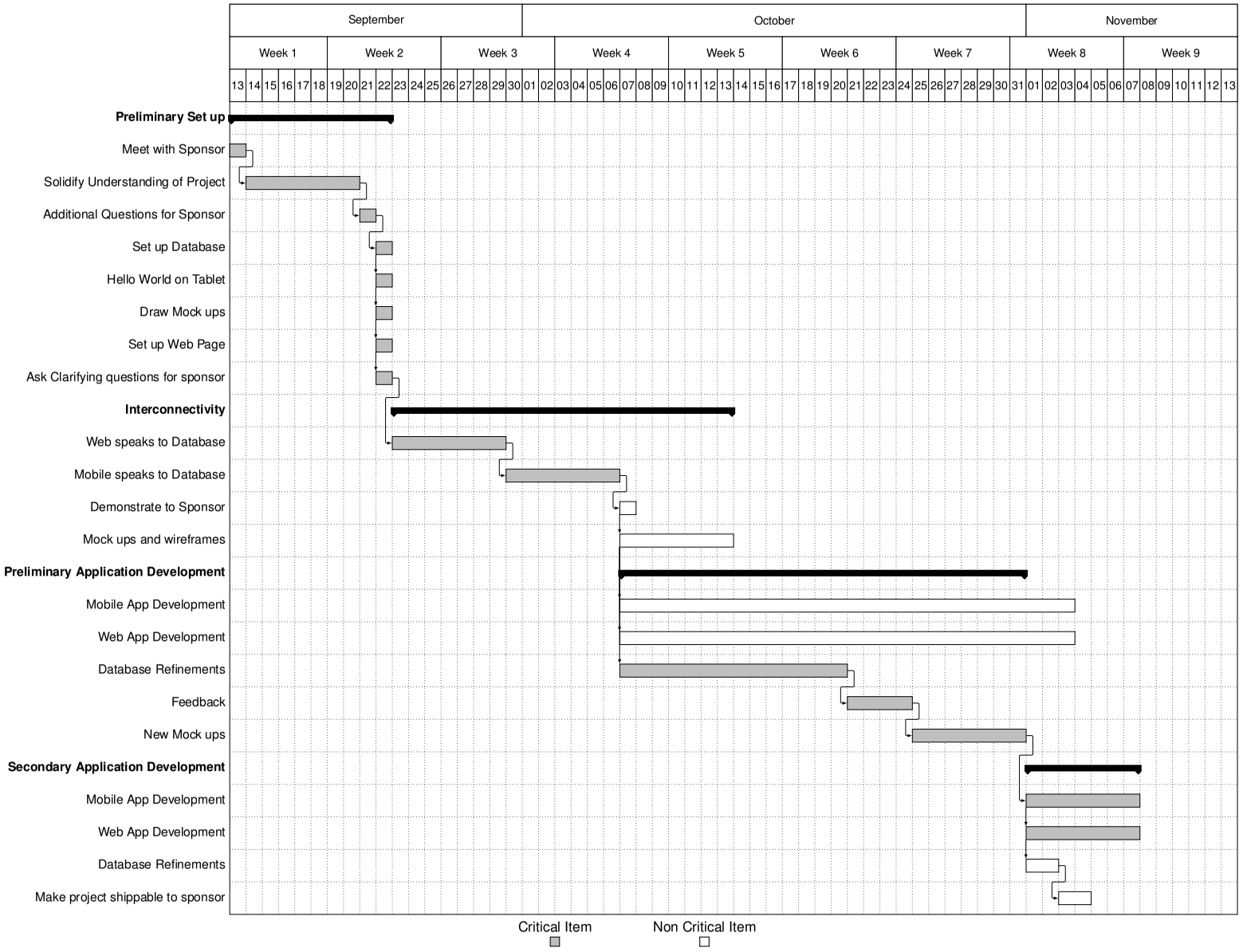

Figure 6: Gantt Chart