

May 15-05: A.R.T.I.M.U.S.

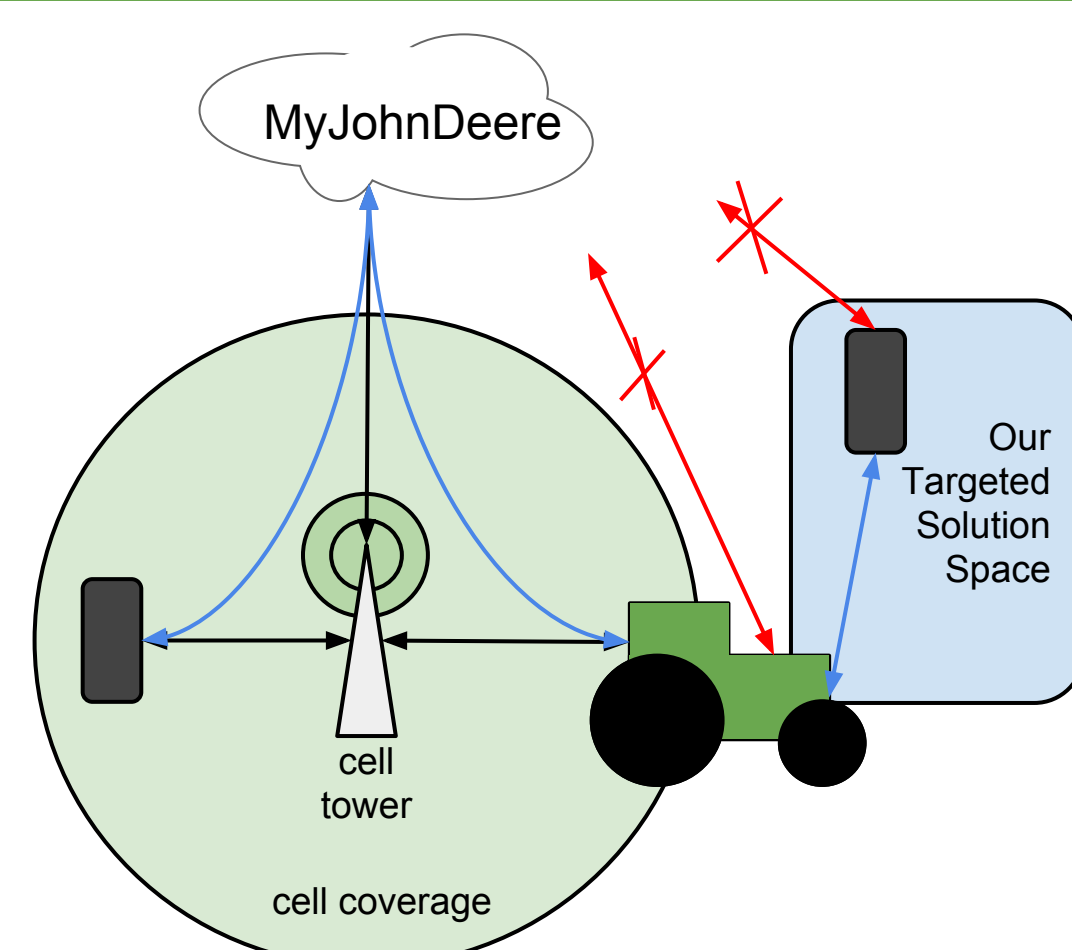
Augmented Reality Tractor Information Management Utility System

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Problem & Solution

John Deere tractors have, onboard, a device called the Modular Telematics Gateway or MTG which acts as a server to collect data from the various instruments, gauges, and equipment throughout the vehicle. The MTG has a cellular card which allows it to forward this data to John Deere servers which can be accessed through the John Deere API.

However these tractors are often in the field and may not have access to cellular connection to download this information directly. Our application for iOS devices bridges this gap by connecting to the MTG which, when connected to a TPLink device, can act as an Access Point. By establishing a TCP connection to a server application running on the MTG we are able to download the maintenance data directly from the tractor and display it.



Problem Visualization and Solution Target

Our application makes use of augmented reality software to identify tractors using the iPhone camera to see the tractor and display pertinent alerts real time.

Design

Amongst target audience (John Deere Tractor owners) about 53% were using the iOS platform. Our application was to run on iOS 7 and up and was to be tested using iPhone 4 and 5.

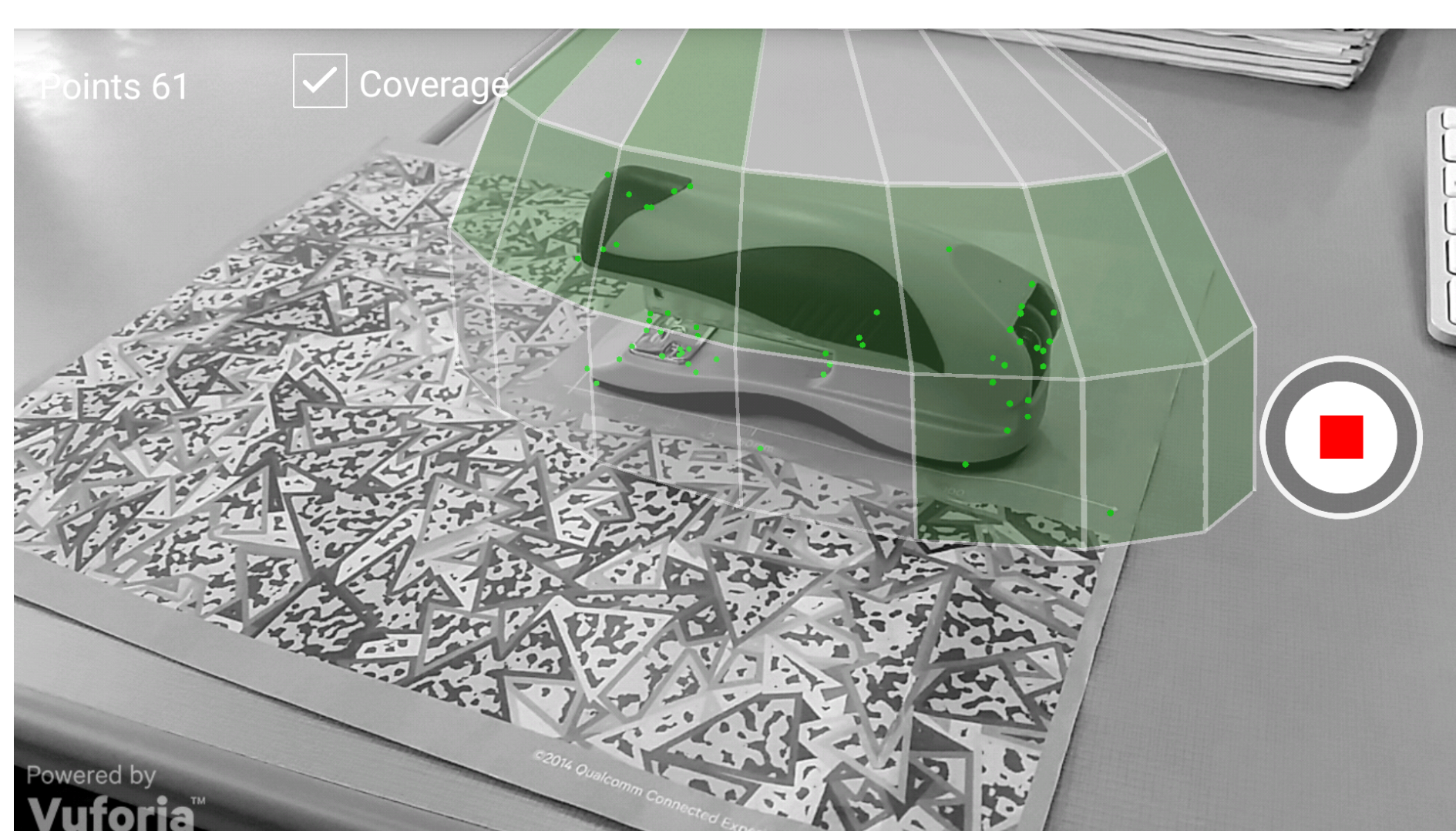
Functional Requirements

- Connect directly to on board MTG server
- Provide an Augmented Reality view, overlaying critical maintenance information on the tractor in real time
- Manage maintenance information on multiple vehicles and displaying alerts when passing critical thresholds
- Operate in 3 modes: Farmer, Dealer, and Developer

Components

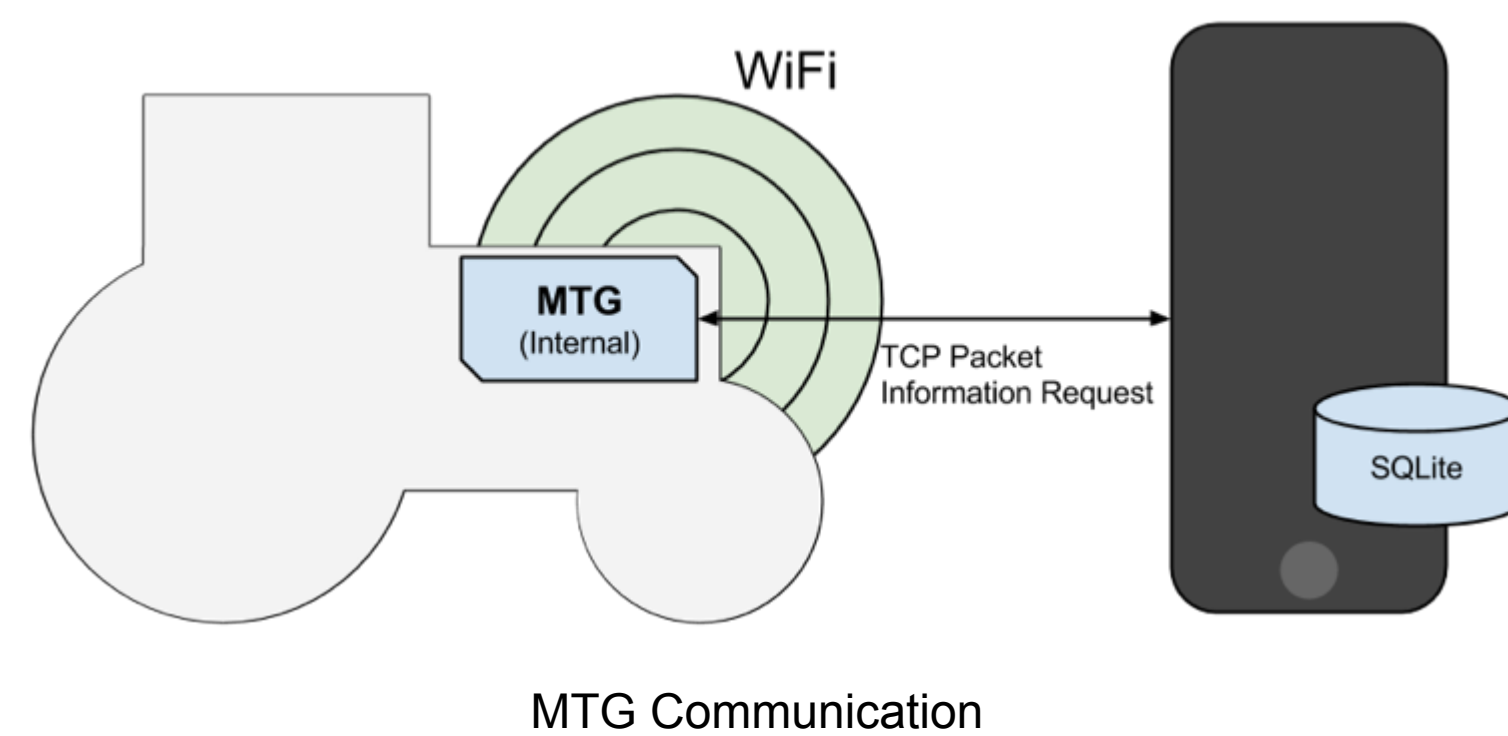
Augmented Reality

- Uses Qualcomm Vuforia SDK for Image Recognition and Augmented Reality Overlay
- Recognizes saved vehicle objects and displays relevant data and alerts pulled from MTG
- Recognizable objects are created with the Vuforia Object Scanner App, which are then uploaded to the device database
- Overlay is displayed on-screen around the vehicle once the vehicle is recognized



MTG Communication

- Simple communication protocol for transferring data between device and MTG
- Transmit serialized binary data over WiFi and a TCP Connection
- Store and display tractor maintenance information.

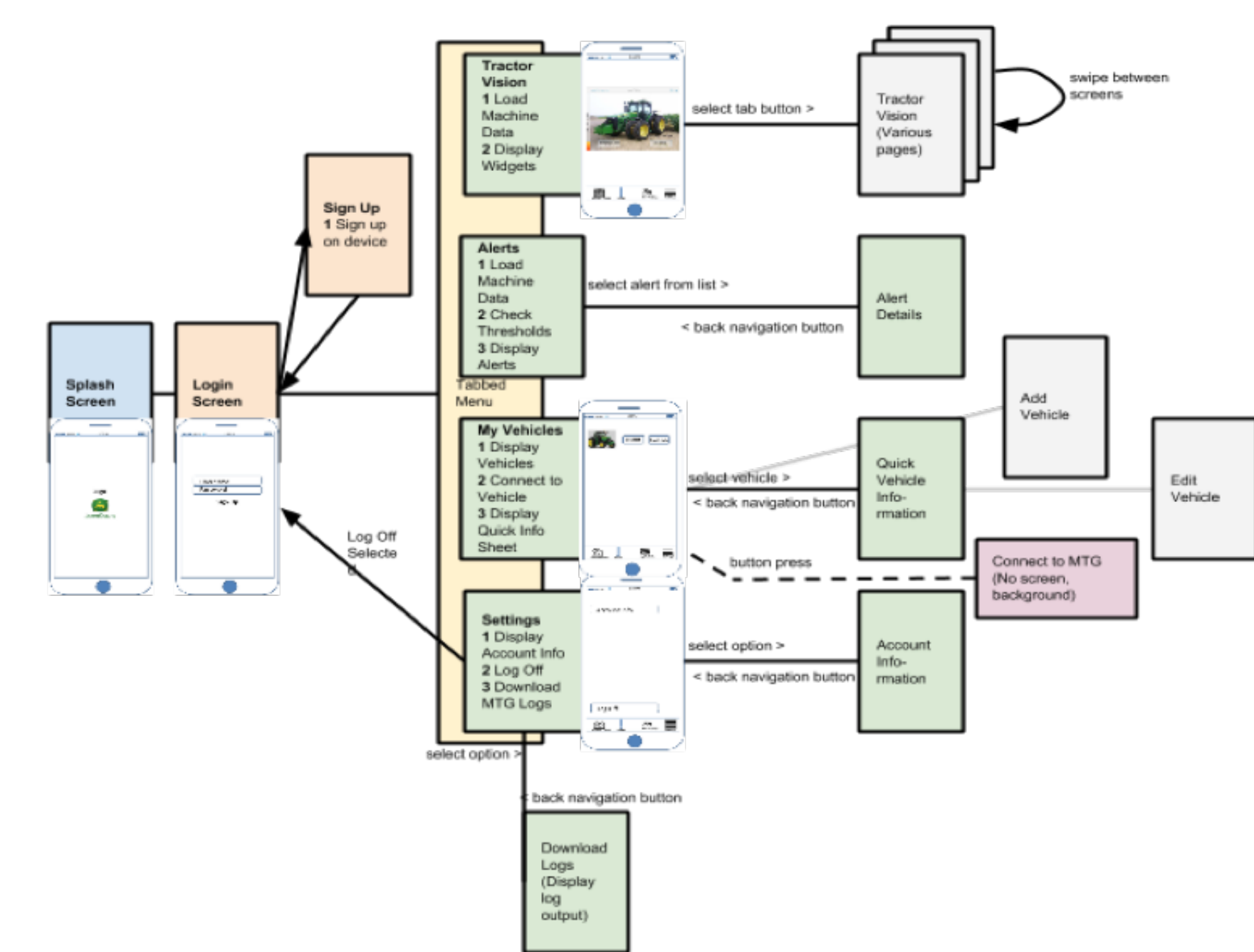


MTG Communication

Current versions of the MTG do not have a built in WiFi chip but it did have an ethernet port. Using a TPLink device configured to work as an Access Point and a Gateway for the MTG we could establish an individual connection. Future versions of the MTG may have native WiFi capabilities.

Non-functional Requirements

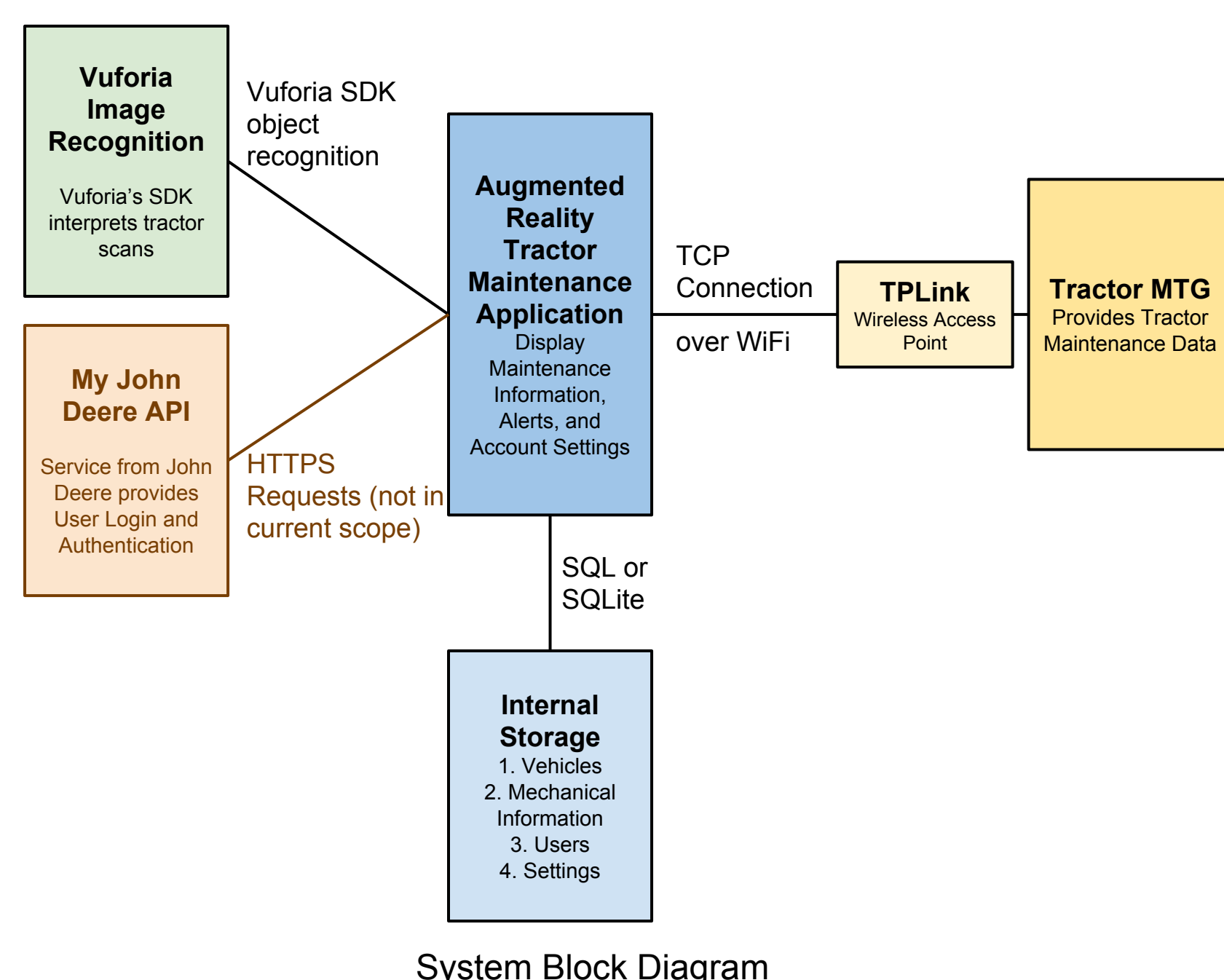
- Run on newer versions of iOS
- Make use of best practices to avoid data leak over WiFi
- Do not reveal information to anyone not an authenticated user



Fundamental Application Screenflow

WiFi Challenges

- Uses WiFi to connect to the MTG
- Apple has prevented iOS developers from integrating in-app WiFi connection for security purposes
- To get around this, the app includes Bonjour, Apple's API for WiFi connectivity
- The challenge now is that the current gen MTG runs on a variation of Windows CE, which does not support Bonjour
- This problem will be resolved in the next gen MTG, which will run on a Linux operating system



System Block Diagram

Thanks to Dr. Benazir Fateh and John Deere Intelligent Solutions Group, ECPe CSG, and Dr. Manimaran Govindarasu, team advisor.

Testing

- SQLite Database Audit
 - For database audit, we tried to develop correct database status, and made sure that every update matches the 'correct' state.
- Hardware Challenges
 - Having no physical hardware to test on without scheduling access with our client to provide a physical MTG server, our team developed a simple server which could run on a laptop to simulate MTG connections.
 - Simple server could run in several modes:
 - Audit Mode: which provided a scripted set of connection data to use for Database Auditing.
 - Random Mode: which provided random data to the application for testing.
- App Simulation/Testing
 - Used black-box testing for design and background processes.
 - Individually worked on each component and tested to see it works fluently on simulator, then added it to base model.