

# Requirements Document

Assistant for Recycling and Waste Management to Reduce  
Recyclables in Landfills

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CS361 Group 18 - Spring 2018

# Introduction

Group 18 was able to reach out to our customer, Elizabeth Premer, and scheduled a call with her on Thursday (4/19) to discuss her vision. The group then met on Wednesday night (4/18) to divide work and gather questions in preparation for the call with Elizabeth. The work was divided among our group as follows: Noah Beach - Specifications/Dataflow diagram, Kevin Christensen - Definitions/Class Diagram, Emmet Cooke - Use Case/Charts, Jacob Leno - Use Case/Charts, Caleb Scott - Use Case/Charts.

## Definitions

### Functional Requirements

- Participating manufacturers of recyclable products (both newly manufactured and recycled) will install a scannable identifier into all produced goods.
- The waste sorting facility shall be equipped with an automated system to scan and sort incoming goods.
- The automated system shall be able to determine if a good has a scannable identifier.
- The automated system shall be able to determine if a good does not have a scannable identifier.
- The automated system shall be able to correlate the scannable identifier to a recyclable material type.
- The automated system shall separate goods with an identifier from goods without an identifier.
- Goods without an identifier shall be sent to a manual sorting line to capture recyclable material from manufacturers not participating in the program or where a scannable identifier is impractical (such as newspaper).
- Goods with an identifier shall be sent to a secondary automated sorting line.
- The secondary automated sorting line shall sort materials into the appropriate category.

### Non-Functional Requirements

- The automated system shall be able to identify tagged versus non-tagged goods a minimum of 90% of the time.
- The system shall be scalable to increase or decrease waste throughput as required.
- The automated system shall have the ability to add or remove recyclable materials from its sorting capabilities.
- The automated system shall correctly identify tagged goods 95% of the time.
- The system shall not take longer than 2 seconds to identify a tagged good.
- The system shall provide a summary of sorted goods.
- The system shall have an intuitive user interface to provide access to diagnostic features.

# Specifications

## Functional Requirements

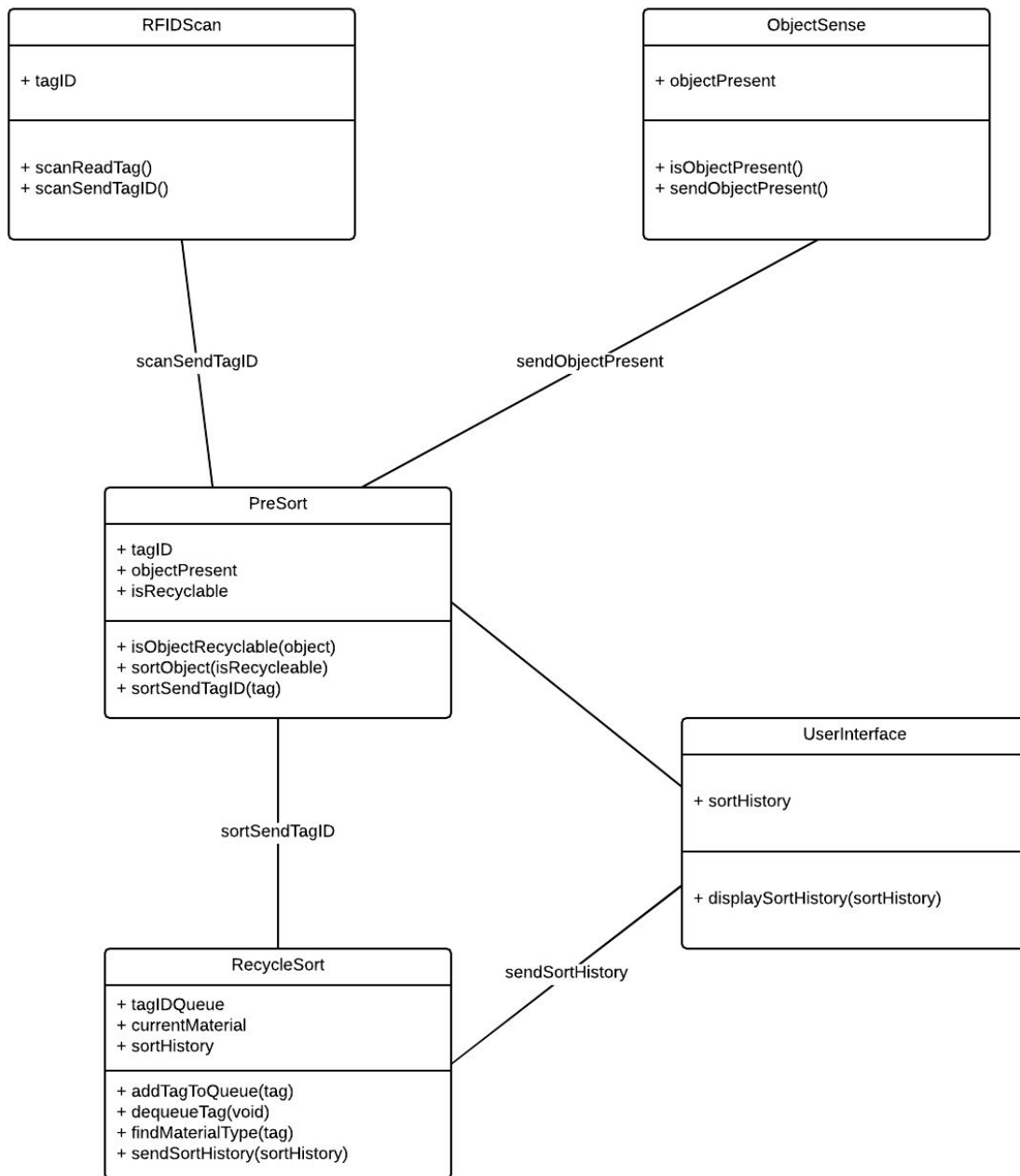
- Manufacturers of recyclable products (both newly manufactured and recycled) will install a passive RFID chip that identifies the product's recyclable category (waste paper, cardboard, plastic, metal, or glass).
- Waste sorting facility system will utilize short range RFID scanners to identify recycling category (waste paper, cardboard, plastic, metal, or glass) of waste. RFID scanners will send out RF energy which will activate the passive RFID chips, the chips then emits a specific signal which corresponds to a recycling category.
- Waste sorting facility system will utilize pneumatics or robotics to automatically pre-sort and separate scannable goods from non-scannable goods.
- Waste sorting facility system will utilize pneumatics or robotics to automatically sort and separate goods by their scanned recycling category.
- Waste sorting facility system will decode the signal received from the RFID chip by referencing a database of categories.
- Goods that are unscannable or report invalid scan data (based on database look up) shall be sent to a manual sorting line to capture recyclable material from manufacturers not participating in the program or where a scannable identifier is impractical (such as newspaper).

## Non-Functional Requirements

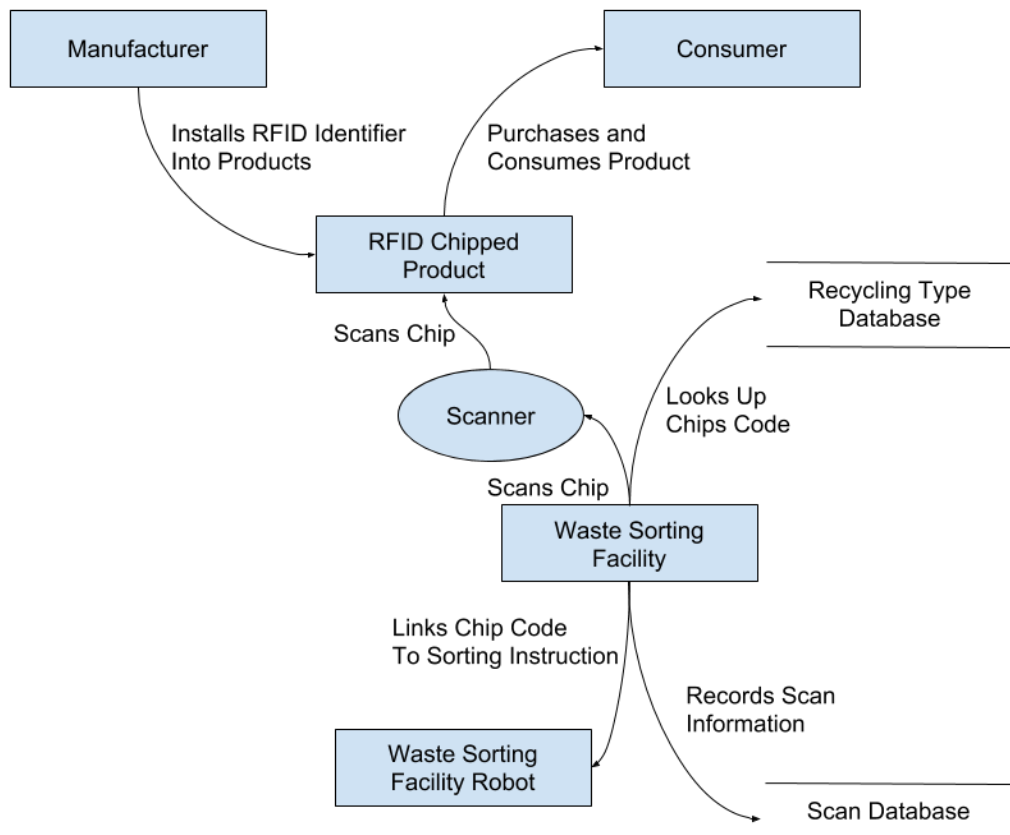
- Since recyclable waste is now sorted by RFID tag at the sorting facilities the traditional compost/trash/recycle bins are no longer required.
- The accuracy of the RFID scanner and chips shall allow for a minimum of 95% scanning accuracy.
- The system must provide a way to update the database of possible recyclable items.
- The speed of the RFID scanner shall take no longer than 2 seconds to scan, recognize, and accurately determine the good's type.
- The system will record a information about each scan to a database for later analysis such as timestamp, tag id, good's recycling category.
- The system shall provide a web interface for the user to maintain, update, and diagnose issues.

# Diagrams

## Class Diagram



## Dataflow Diagram



# Use Case: Recycling Assistant - Landfill Location

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**Actor:** Recycling Assistant sorting robot

## **Preconditions:**

- Trash to be sorted is loaded into recycling assistant conveyor belt/presort machinery
- Some of the trash contains recyclables with embedded RFID chips
- RFID chips are loaded with correct codes that correspond to Recycling Assistant software

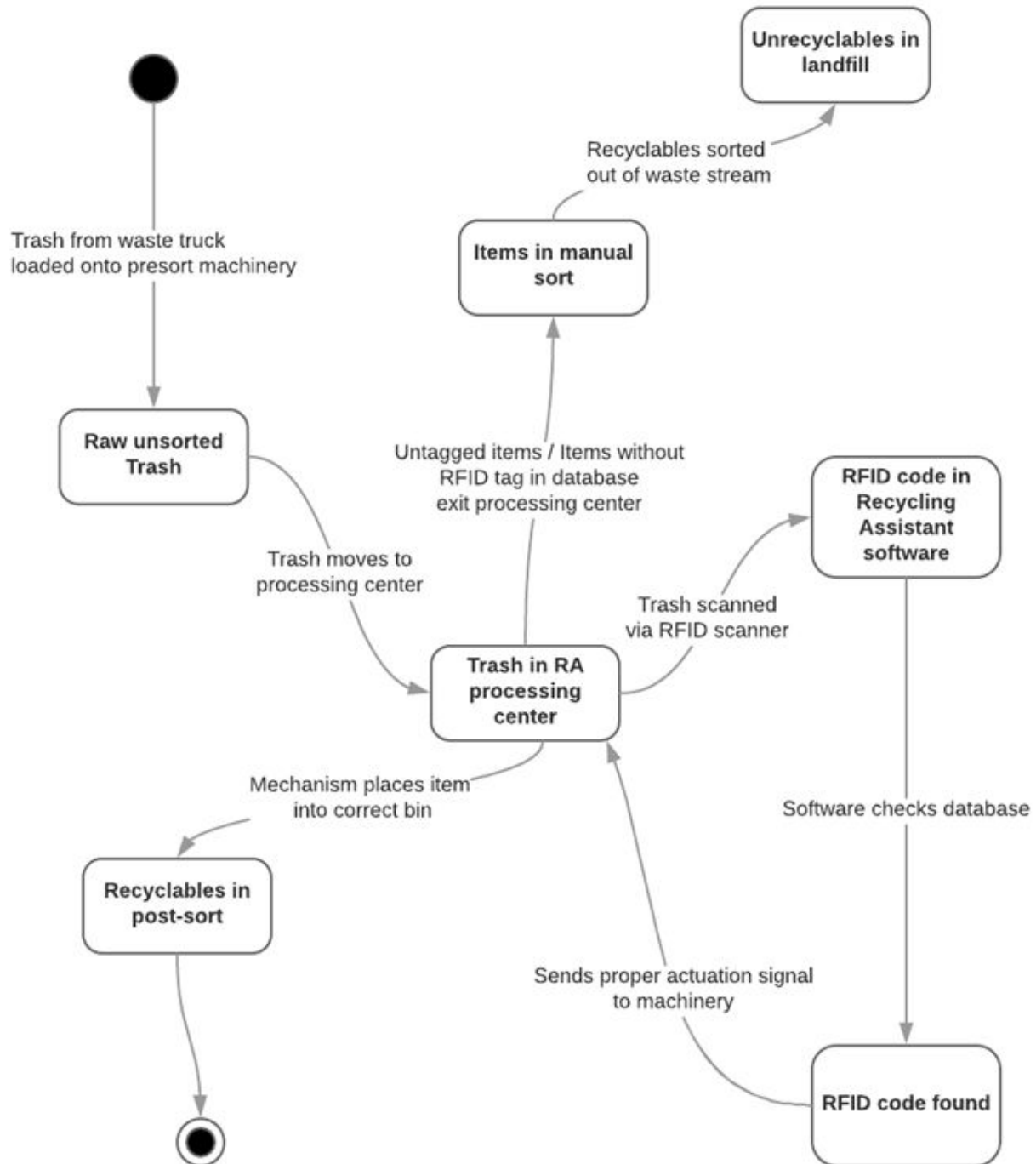
## **Postconditions:**

- All trash that contains recyclable materials embedded with RFID chips is sorted and out of the waste stream
- Mixed trash/untagged recyclables exit the Recycling Assistant and move onto the 2<sup>nd</sup> line of defense for manual sorting
- Trash that has been sorted out of the waste stream is now in a post sort state and certain recyclables such as plastic and glass must undergo a second sorting process

## **Flow of Events:**

- Trash that contains unsorted RFID tagged recyclable materials enters the recycling assistant conveyor belt/presort machinery
- Trash/Recyclables mixture is funneled to the recycling assistant's material processing center and is removed from the waste stream
  - First the recycling assistant scans each item via a RFID scanner
    - The scanner relays the RFID code to the software
    - The software checks its database to find out where to place the recyclable item
    - The software then sends a signal to actuate its sorting machinery
  - The recycling assistant moves the item into its corresponding bin/conveyor belt via a robotic arm, jet of air, or pneumatic rod.
- Items such as glass and plastic that have been removed then move on to the post sort process
- Leftover items in the waste stream are then manually sorted by people and non recyclable material is deposited in the landfill

# State Diagram - Landfill Location



# Use Case: Recycling Assistant - Individual Pre-Sorting

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**Actor:** Recycling mart recycling bins

## **Preconditions:**

- All recyclable material is embedded with passive RFID tags
- RFID tags are loaded with material type from Recycling Assistant software
- Recycling bins have multiple compartments with active RFID chips that scan the passive RFID tags and only open the correct compartment for the specific recyclable
- Anything without a tag will go into the waste bin to be sorted manually at the main recycling facility

## **Postconditions:**

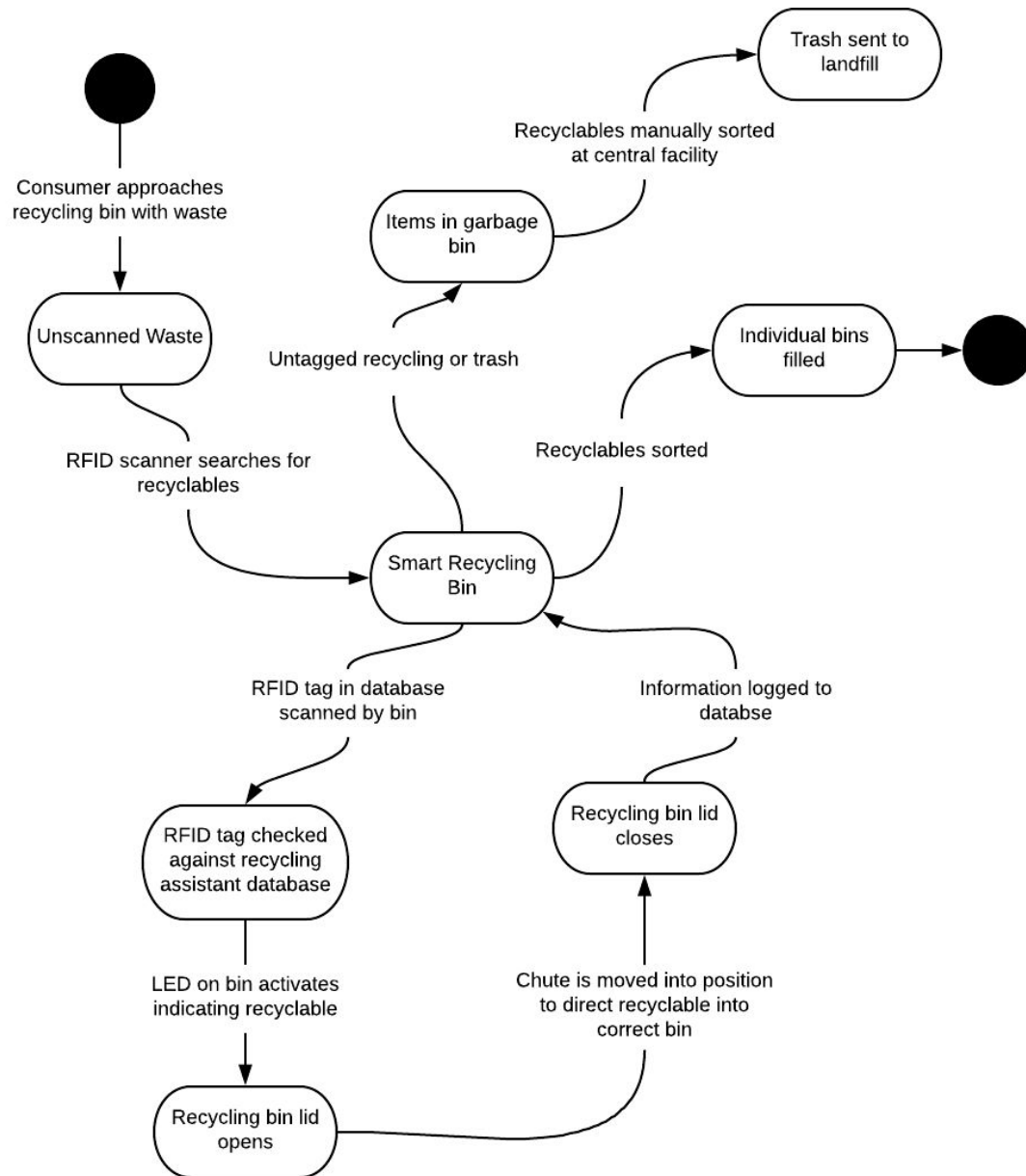
- All waste containing RFID tags are counted and pre-sorted by the recycling assistant reducing the strain on the central sorting facility
- Waste without RFID tags are forwarded along to a central sorting facility to be sorted manually
- Initially sorted recyclables such as plastic can be sent to be further sorted into specific types; e.g. PET, HDPE, PVC, etc.

## **Flow of Events:**

- Consumer creates waste whose packaging contains RFID tags and upon approaching a recycling bin the recycling assistant scans the waste
  - The RFID scanner reads the passive RFID tag
  - The Recycling Assistant software checks the database to determine the final location for the item
  - The software sends a signal to activates an LED light letting the consumer know the item is recyclable
  - An actuator is triggered to open the lid on the main recycling bin
  - The scanner detects when the object is placed into the bin
    - The item is logged into the database
    - A motor is activated to control a chute which directs the recyclable material into the appropriate bin
    - The lid actuator is triggered again to close the lid and reset to wait for the next item
  - Non-recyclable waste or non-tagged waste will be able to be disposed of next to the recycling bin for later sorting or disposal



# State Diagram - Individual Pre-Sorting



# Use Case: Recycling Assistant - Transportation Sorting

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**Actor:** Recycling Assistant sorting robot within a truck

**Preconditions:**

- The Trash has been picked up and loaded into Recycling Assistant that is onboard the garbage truck
- Some of the trash that has been loaded into the truck contain embedded RFID chips
- The truck has been compartmentalized to allow the tagged recyclables to be sorted before arriving at the waste collection location

**Postconditions:**

- The recyclables with embedded RFID chips within the truck have been sorted by the recycling assistant according to material
- Upon arrival at the waste collection location, the bins containing the different recyclable materials are removed and emptied
- Trash, or untagged recyclables, that were not sorted by the Recycling Assistant are sent to a second sorting line where it is manually sorted

**Flow of Events:**

- Trash is continuously collected in the back of the garbage truck
- The onboard Recycling Assistant begins sorting through the available material
  - A scanner does a sweep over the top level of trash to see if it can locate any RFID chips
  - This scan relays the RFID code of the scanned chips to the Recycling Assistant
  - The Recycling Assistant then checks its database to see which container the material should be placed into
  - Once this has been determined, a robotic arm with powerful suction picks up the item and deposits it into a container for that type of recyclable towards the front of the truck
  - If there were no RFID chips discovered when scanned, the trash at the bottom of the truck is rotated to the top and the process begins again
- Once at the waste management center, the bins containing the sorted recyclable material are removed from the truck and delivered to their respective locations for processing
- Empty bins are placed into the truck for further use

# State Diagram - Transportation Sorting

