

October 10, 2011  
Dr. Andrew Rawicz  
School of Engineering Science  
Simon Fraser University  
Burnaby, BC  
V5A 1S6

**RE: ENSC Functional Specifications for Advanced Shopping Cart**

Dear Dr. Rawicz,

The enclosed document details the functional specifications for the “Advanced Shopping Cart” from the Smart Buy team. We are upgrading existing shopping carts with an electronic system that will solve many prevalent issues, such as theft, checkout time, and inventory management.

The functional specifications in this document will be a basis for all future iterations of prototypes and products, and act as a reference when new operational modifications are made. All members of Smart Buy will adhere to these specifications in future design and production processes.

The Smart Buy team is comprised of five fourth-year electronic engineering students; Hank Cheng, Leslie Man, Zhiyou Bill Lu, Tom Pan, and Jeffery Chung. Each member brings unique skill sets and experiences to this project.

For any inquiries or comments regarding our project, please contact our team through our CEO Hank Cheng, via email at [Hca62@sfu.ca](mailto:Hca62@sfu.ca) or telephone by 778-988-1688.

Sincerely,



Hank Cheng

Chief Executive Officer  
Smart Buy  
Enclosed: Proposal for Advanced Shopping Cart



# Functional Specification

## For an Advanced Shopping Cart System



### **Project Team**

Hank Cheng  
Leslie Man  
Zhiyou Bill Lu  
Tom Pan  
Jeffery Chung

### **Team Contact**

Hank Cheng  
Hca62@sfu.ca

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### **Submitted To**

Dr. Andrew Rawicz  
Michael Sjoerdsma  
School of Engineering Science  
Simon Fraser University

## Executive Summary

Grocery shopping is an integral part of Canadian life; however, this activity is perceived in different ways by the consumers. For some shoppers, the weekly stock-up trips are associated with leisure, while others see it as a chore. The “Advanced Shopping Cart” (ASC) offers a system that will serve both mentalities, while also dealing with theft and security issues present in most markets.

The product is an add-on that upgrades existing shopping carts, and will be easy to implement in existing market infrastructures. The system can be defined as two units; an on-cart electronic system and a checkout station which also runs as a central database server.

The prototype database server currently operates on Windows environment and broadcasts using a wireless router, which allows information to be sent and received wirelessly from all on-cart systems. This setup can safely and efficiently update information on all carts, and can be easily implemented in any market. The checkout station will be able to identify the information stored in the tablet that has been scanned and display it on screen.

The on-cart system includes a tablet, which incorporates a touchpad, digital display, wireless receiver, and serves as the operating system and host to an RFID reader. The touchpad/digital display gives consumers an interactive way to receive store information and manage their personal inventory, while the tablet itself will be able to communicate with the database server and update its information. The RFID reader will have a range of one meter, which when properly placed will envelope the carrying spaces on the particular shopping cart. This eliminates the need for customers or cashiers to scan purchased items, and will significantly reduce theft in self-services.

The functional specifications in this document are designed for the initial prototype of “ASC”. Future iterations will be purposed to improve aesthetics, hardware, and software setup that will lower the cost of manufacturing, implementation, and maintenance, while retaining all functionalities. New functionalities will also be explored, such as GPS navigation, wireless charging systems, and portability.

For such common-use products that will be exposed to direct contact with consumers, issues of safety, usability, and reliability will be emphasized. The Smart Buy team will diligently adhere to these principles and strive to create more efficient and innovative designs.

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## Glossary

ASC Advanced Shopping Cart

RFID Radio Frequency Identification

## Introduction

ASC is an electronic add-on system for existing shopping carts. It is an upgrade that addresses several issues prevalent in supermarket environments such as checkout efficiency and theft, by introducing an electronic component. The system can be classified into two units; a central database server and the on-cart electronics. The database server will be capable of wirelessly broadcasting to and receiving information from all on-cart devices. The electronic device attached to each cart will have a tablet with touchpad display and a RFID reader with a range of one meter. Customers will be able to receive store information on the tablets in real time and manage their inventory, while avoiding the need for barcode scanning. The full functional specifications are detailed in this document.

## Scope

This document details the functional requirements that must be met by the “Advanced Shopping Cart”. The specifications in this document fully describe the functionalities of our proof-of-concept prototype, and will serve as a basis for future iterations of the product. Possible design modification and consideration of future functionalities will be included.

## Intended Audience

This document is intended to serve as reference material for the Smart Buy team. The functional specifications will be an outline for all design decisions of ASC, and will act as a guideline during design, development, and production.

The overall organization of the development process and milestones can use this document as a reference. The secretarial management of project progress and schedule can also use this document as a guideline.

The information in this document is also available to the marketing division, provided as assistance to clearly identify specific functionalities and its market appeals.



## Classification

In this document, the following notation will be used to define requirements:

### **[R-##-p]**

A functional requirement.

Where 'R' stands for the functional requirements, '##' stands for the requirement number and 'p' is the priority of the functional requirement.

The priority levels are shown below:

**I**

The requirement applies to the proof-of-concept system only.

**II**

The requirement applies to both the proof-of-concept and final production system.

**III**

The requirement applies to the final production system only.

## System Overview

The system overview is given in figure 1.

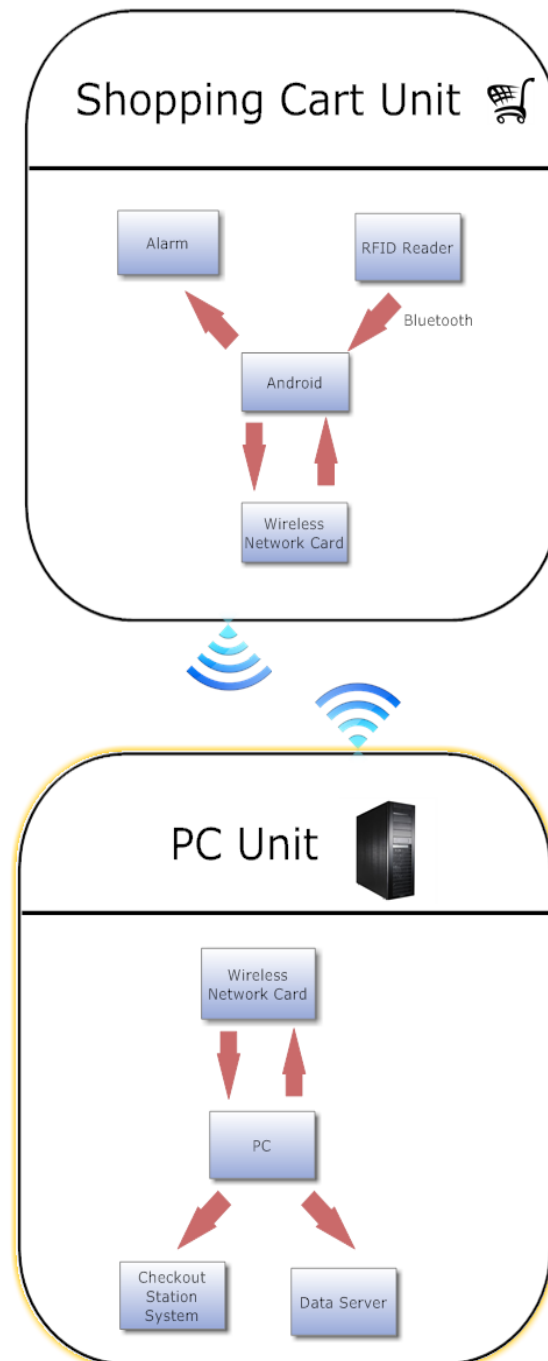


Figure 1 : System Overview

The ASC is a revolutionary model of current shopping cart which consists of two major units, the Shopping Cart unit and the PC system unit. The two units communicate through Wi-Fi network and the database between them can be synchronized in this way. The ASC provides the user of a better and efficient method of shopping by scanning the RFID tag on products automatically, thus, it totally eliminates the process of scanning product barcodes.

The Shopping Cart unit consists of three parts, the shopping cart itself, the RFID reader, and tablet. The RFID reader will be mounted at the bottom of the basket of the cart and automatically detect any item that has a RFID tag. As the RFID reader detects an item, the RFID tag data would be sent via Bluetooth to the Android tablet located in the cart's handle area, and then the tablet would display the information corresponding to the detected item on the screen. An alarm system would also be implemented to ensure the security the tablet. Moreover, the tablet would be designed to be portable in order to make the battery charging easier and more convenient.

As for the PC system, it shall perform the role of a central system which has a local database server in which the shopping carts can synchronize with. The database consists of information such as price, nutrient detail, weight and picture of each item in store. Secondly, the PC unit also acts as a cashier counter, which would identify which ASC is checking out and the total price of the purchase for store record. Figure 2 below shows the overall system.

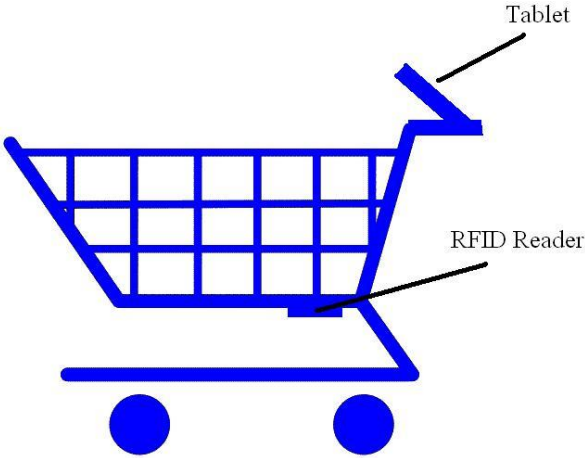


Figure 2 : Shopping Cart

## Entire System Unit

The entire system consists of a shopping cart, RFID reader and a monitor.

## General Requirements

[R-01-1] The system cost shall be under \$400

## Physical Requirements

[R-02-2] The system shall be water-proof and shock-proof

[R-03-2] The system shall be compatible with different brand of shopping cart

[R-04-2] The electronic components shall be enclosed in a waterproof casing

## Mechanical Requirements

[R-05-2] The system shall be able to move with four wheels

[R-06-3] The system shall be able to sense item purchase

## Environmental Requirements

[R-07-2] The system shall be able to perform under extreme wet condition

[R-08-2] The system shall be able to operate at zero to 100 percent humidity

## Reliability and Durability

[R-09-3] The system firmware shall be upgrade daily

[R-10-3] The system shall be able to sense item on the cart

[R-11-2] The system shall have resistance under normal operating conditions

[R-12-2] The system shall have resistance against water and snow

[R-13-3] The system shall be able to service for no less than 3 years

## Safety Requirements

[R-14-2] The items shall not be outside of the cart

[R-15-2] The system shall not be put in extreme heat or extreme cold

[R-16-2] The four wheel shall be safely install

## Usability

[R-17-3] The system shall be easy to use to anybody

## Standard

[R-18-3] Adhere to ISO 19777-2 standard for applying Java during design process.

[R-19-3] Adhere to ISO 18028-4 standard for adding security system to our product.

[R-20-3] Adhere to ISO 14496 standard for coding visual effects for grocery item.

[R-21-3] Adhere to ISO 15961 standard for applying RFID technology in our product.

## Shopping Cart Unit

### General Requirements

- [R-22-3] The shopping cart shall be light enough for any customer to use.
- [R-23-2] The tablet shall be well secured from the mount.
- [R-24-3] The tablet system shall not be intrusive to the user.
- [R-25-2] The shopping cart shall be able to move

### Mechanical Requirements

- [R-26-2] The shopping cart shall have a RFID scanner that auto scans any item dropped in the cart.
- [R-27-2] The securing mechanism shall use an alarm beep when active.
- [R-28-2] The tablet installed in the handle shall not block the customer from pushing the handle.
- [R-29-3] The tablet shall be able to portable and only be detached by store staff
- [R-31-2] The tablet shall be able to charge by AC adaptor.

### Reliability and Durability

- [R-32-2] The unit shall withstand the force generated from the user's pushing force.
- [R-33-2] The tablet unit shall able to able to endure rain, snow and other extremely weather conditions.
- [R-34-3] The tablet unit shall able to endure any other external forces made by sharp tools such as knife and screw driver.

### Performance Requirements

- [R-35-3] The total weight of the Cart shall not exceed 10 kilograms.
- [R-36-2] The tablet system shall provide customers with the total sum of their shopping.
- [R-37-2] The tablet system shall provide nutrient information upon scanning each item.
- [R-38-3] The tablet system shall come in three languages, English .French and Chinese.
- [R-39-3] The tablet system shall show the user the quickest route to all the grocery entered.
- [R-40-3] The tablet system shall able to sync with the central system and updates every 15 minutes.
- [R-41-3] The tablet system shall be active within 30 seconds upon active
- [R-42-3] The shopping cart shall have a signal warning the customer that he/she is out of range of store.

## Monitor

The monitor's main function is to provide a user interface so customers can access the applications on the Android system. The monitor will be adjustable to support customer with different height. The monitor will be touch screen so customer can check their inventory and the overall price very easily.

### General Requirements

- [R-43-3] The angle between the monitor and the cart shall be adjustable electronically with a range of 90 degree.
- [R-44-2] The monitor shall automatically update when new inventories in the cart are changed.

### Physical Requirements

- [R-45-3] The width of the monitor shall be at least 10 cm.
- [R-46-3] The length of the monitor shall be at least 8 cm.
- [R-47-2] The monitor shall be water proof.
- [R-48-3] The monitor shall be removable.

## RFID Reader

RFID Reader receives the signal from RFID chips and identifies the inventory. The reader will be constantly checking for new inventories entering or leaving the cart.

### General Requirements

- [R-49-3] The range of the RFID reader should cover the volume of the cart
- [R-50-3] RFID Reader should be accurate and only count the inventory inside the cart
- [R-51-3] RFID Reader should be user friendly and there should not be any work for the user

### Physical Requirements

- [R-52-2] RFID Reader should be water proof
- [R-53-2] RFID Reader should be small and does not consume much space of the cart

## User Interface Unit

The User interface unit shall consist of a touch screen monitor which allows the user to scroll up and down. Signals from the RFID receiver will transmit to the processor as input through wireless connection. The monitor will display information such as the purchased inventory and their related price as output.

## General Requirements

- [R-54-2] The primary means of user input shall be through the touch screen
- [R-55-2] The outputs on the user interface shall display the battery level

## Usability Requirements

- [R-56-3] The user interface shall be intuitive and easy to use

## Physical Requirements

- [R-57-2] Touch screen monitor shall be easily accessible by the user

## PC System

### General Requirements

- [R-58-2] There shall be an Android tablet ID recognition system.
- [R-59-2] The system shall allow the user to update the product database.
- [R-60-2] The system shall allow the user to manage the stock inventory.
- [R-61-2] The system shall be able to communicate with Android systems on shopping carts.

### Reliability

- [R-62-2] The system should be able to handle the situation when wireless network is disconnected

## Alarm System

### General Requirements

- [R-63-3] The alarm shall turn on when the tablet is removed from the cart without authorization

### Physical Requirements

- [R-64-2] The alarm shall make some noise when turn on

## System Test Plan

The development of ASC will follow four in-depth testing stages. All units will be tested individually in the first testing cycle. The first test cycle will ensure individual component meets its specifications and functions properly. The second test cycle will ensure each individual parts works together after integration. The next stage is to conduct qualitative testing for typical user scenarios. The final testing stage will test for different system failure cases.

## Android System

- Ability to access the PC (remote database server) in wireless LAN network through HTTP protocol.
- Ability to run developed application without errors.
- Ability to receive RFID data through Bluetooth communication.
- Ability to stay powered for at least 12 hours.

## RFID Reader

- Ability to read RFID tag data in long distance.
- Ability to send RFID tag data through RS-232 port.

## Bluetooth to Serial Adapter

- Ability to pair with Android system.
- Ability to send the input RS-232 data through Bluetooth data transmission.

## PC

- Ability to manually update the database.
- Ability to manage stock inventory.
- Ability to identify the unique ID of each Android tablet.

## Alarm

- Ability to turn on or off when the switch is activated or deactivated.

## Integration Testing

### PC Unit

- Ability to get the list of items in the shopping cart
- Ability to print a receipt

### Shopping Cart Unit

- Ability to communicate with the RFID reader through Bluetooth.
- Ability to communicate with the server through Wi-Fi.
- Ability to activate the alarm when the tablet is detached from the shopping cart.
- Ability to show product information through user interaction.

## Qualitative Testing

### Typical User-Scenarios

- Operation in cold and humid condition.



- Volatile vibration and shocking.
- User accidentally presses buttons to switch to other interfaces from the current screen.
- Shopping carts exposed in rain and snow.

## **Failure Testing**

### **Typical Improper-Use Scenarios**

- Android table battery runs out
- RFID reader battery runs out

## Conclusion

The functional specifications detailed in this document outline the full requirements for the proof-of-concept prototype of ASC and will serve as a basis for future iterations of the product if applicable. The proof-of-concept prototype will be presented in December, and will adhere to this document. Future functionality considerations will be pursued in other iterations if time permits.

## Reference

[1]

International Organization for Standard ( May 2006). ISO 19777-2006 - information technology -- Computer graphics and image processing -- Extensible 3D (X3D) language bindings -- Part 2: Java. Retrieved Oct 12, 2011 from <http://www.iso.org/iso/search.htm?qt=ISO+197772+&searchSubmit=Search&sort=rel&type=simple&published=on>

[2]

International Organization for Standard (April 2005). ISO 18028-4:2005- information technology -- Security techniques -- IT network security -- Part 4: Securing remote access. Retrieved Oct 12, 2011 from <http://www.iso.org/iso/search.htm?qt=ISO+180284&searchSubmit=Search&sort=rel&type=simple&published=on>

[3]

International Organization for Standard (May 2004) . ISO 14496- 8:2004 -Information technology -- Coding of audio-visual objects -- Part 8: Carriage of ISO/IEC 14496 contents over IP networks Retrieved Oct 12, 2011 from <http://www.iso.org/iso/search.htm?qt=ISO+14496+&searchSubmit=Search&sort=rel&type=simple&published=on>

[4]

International Organization for Standard (Oct 2004) . ISO 15961 :2004 - Information technology -- Radio frequency identification (RFID) for item management -- Data protocol: application interface. Retrieved Oct 12, 2011 from <http://www.iso.org/iso/search.htm?qt=ISO+15961+&searchSubmit=Search&sort=rel&type=simple&published=on>