ENSC 305W/440W Grading Rubric for Functional Specification

Criteria	Details	Marks
Introduction/Background	Introduces basic purpose of the project.	**/05%**
Content	Document explains the functionality of the proposed product without excessive design content (i.e., outlines the "what" rather than the "how").	**/10%**
Technical Correctness	Ideas presented represent valid functional specifications that must be considered for a marketed product. Specifications are presented using tables, graphs, and figures where possible (rather than over-reliance upon text).	**/15%**
Process Details	Complete analysis of problem. Justification for chosen functionalities. Sources of ideas referenced. Specification distinguishes between functions for present project version and later stages of project (i.e., proof-of-concept, prototype, and production versions). Comprehensively details current constraints.	**/20%**
Engineering Standards	Outlines specific engineering standards that apply to the device or system and lists them in the references.	**/10%**
Sustainability/Safety	Issues related to sustainability issues and safety of the device are carefully analyzed. This analysis must cover the "cradle-to-cradle" cycle for the current version of the device and should outline major considerations for a device at the production stage.	**/10%**
Conclusion/References	Summarizes functionality. Includes references for information from other sources.	**/05%**
Presentation/Organization	Document looks like a professional specification. Ideas follow in a logical manner.	**/05%**
Format Issues	Includes letter of transmittal, title page, executive summary, table of contents, list of figures and tables, glossary, and references. Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted.	**/10%**
Correctness/Style	Correct spelling, grammar, and punctuation. Style is clear concise, and coherent. Uses passive voice judiciously.	**/10%**
Comments		

Functional Specification for the AccuTag System

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October 14, 2013

Mr. Lucky One

School of Engineering Science

Simon Fraser University

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Re: ENSC 440 Functional Specifications for Wireless Electronic Price Tag System

Dear Mr. One,

Precision Wireless is pleased to present you the enclosed functional specifications document which outlines the handy specifications of our AccuTag system. This document details the functional aspects needed to implement one or more E-Ink screens with the ability to display prices and product information wirelessly. It is through this product that we hope to reduce the use and maintenance of paper price tags currently in practice in the market today.

The enclosed document provides guidelines for the operational requirements needed for an efficient development of the AccuTag system. It provides a general overview of both the hardware and software requirements necessitated to implement a fully functional prototype of our display system set to meet the design standards of a competent cost effective design.

As a team, we would appreciate your consideration and time in reviewing our project proposal and encourage questions or concerns which may arise in the process. Should you have any concerns, please feel free to contact me at mmehran@sfu.ca or by phone at (778)-859-8070

Sincerely,

M. Mehran

Mahyar Mehran
Chief Executive Officer (CEO)
Precision Wireless

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Executive Summary

Nowadays supermarkets are striving to become efficient and eco-friendly in today's economy more so than ever, with sales occurring on a daily to weekly basis in order to stay in direct competition with the next leading grocery store. Consequently we at Precision Wireless believe that any company willing to pursue a further streamlined model of operation in their day to day activities as well as save thousands of dollars while simultaneously reducing their negative impact on the environment should invest in our AccuTag digital price tag system.

This AccuTag system consists of two main components: an in-store transmitter and a set of digital E-Ink LCD price tags. The price tags will be wirelessly controlled by the transmitter using Radio-Frequency transmission which will have access to a catalogue of prices that are constantly up to date. Each digital tag is identified based on its specific aisle, section and item ID which is stored in a database. This connection is what will make our product so efficient and convenient. Store employees will no longer be required to update the tags manually via the typical paper tag method as these digital tags require almost no maintenance until they are broken or their batteries die out which can take many years.

The main goal in the design of this system is to create an environment that requires the least amount of maintenance while not just being up-to-par with the quality of old paper tags but many times better. The overall installation process after a supermarket has committed to our product will consist of a onetime quick and easy visit from our panel of experts who will then carry out the setup of the transmitter and give tutorials on digital price tags maintenance and software use. Once this critical initial step is complete, ideally, the store should never again be required to worry about the changing of their price tags as it will all be electronically controlled through the use of a computer.

The AccuTag system will not only benefit big companies like Superstore and Wal-Mart but will also be designed with the everyday shopper in mind. Key aspects regarding display visibility, product correlation and on-sale representation have also been included in functionality and design criteria.

The remainder of this document will provide an in depth analysis of our system's software and hardware functional specifications. There will also be additional topics covered in the following outline.

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Glossary

Central Transmitter Unit - The central transmitter unit is the transceiver that communicates the information from the database to the price tags.

LCD and E-ink display - The terms LCD and E-ink display are used interchangeably. The LCD that we have selected for both our proof of concept design as well as the final product is an e-ink display.

DUT - Device Under Test

PER - Packet Error Rate

dBm - dBm is an abbreviation for the power ratio in decibels (dB) of the measured power referenced to one milliwatt (mW)

Tag - Tag is a term used to refer to the system with a microcontroller, transceiver as well as the e-ink display.

UPC - Universal Product Code

API - Application Programming Interface

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1. Introduction

The AccuTag System by Precision Wireless is a full-fledged replacement for the traditional paper tag solution that is used by almost all retail establishments around the world. It is comprised of a collection of digital and wirelessly controlled price tags that can have their prices or messages updated via a transmitter within the store. The transmitter will interface with a computer or server from which it will fetch updated prices for individual items and broadcast the data to the AccuTag price tags. The requirements for the AccuTag System are documented in detail in the remainder of this functional specification.

1.1 Scope

The scope of this specification is to fully outline the functional requirements and features of the AccuTag System. Although a production quality system will have more superior features than the rat's nest prototype that we are building, this document will still outline the requirements for both types of products.

1.2 Intended Audience

The intended audience for this document is the Precision Wireless team, Lucky One, Michael Sjoerdsma, and the TAs. This specification can be used by our team as a means to guide our development process by giving us a clear idea of when a certain feature or requirement can be considered complete. Additionally, the same document can be used by our professors to gauge our progress throughout the semester and decide whether or not our final prototype has met requirements that we have outlined here.

1.3 Classification

We will be classifying our requirements according to the following naming convention.

Rn-p A functional requirement

where the letter **n** stands for the requirement number and **p** stands for the priority. Priority is further classified into the following two categories:

A - Requirement viable for both the proof-of-concept system and the final designed product. Precision Wireless will present the proof of concept design or a functional prototype with the requirements **'A'** fulfilled by December 2013.

B - Requirement viable only for the final designed product. Precision Wireless intends to work on the final product requirements **'B'** post December 2013 in order to explore the possibility of the commerciality and viability of the AccuTag system as a fully functional marketable final product.

2. System Requirements

2.1 System overview

A high level diagram of the components of the AccuTag system is shown below.

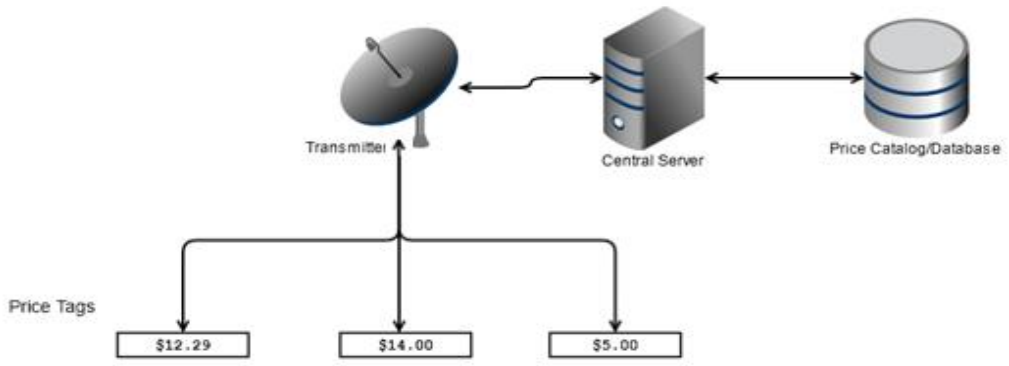

Figure 2.1.1: High-level diagram of the AccuTag system

The system mainly consists of three parts namely the central database containing info about the prices, the central transmitter that transmits the information to the price tags as well as the price tags which receive the information and display them accordingly.

The central database will be able to store information about the price, weight/volume information, company name and logo as well as the barcode associated with each product in the supermarket. The database will also be capable of being modified through a central headquarter server via the internet if the company in question using the AccuTag system has a chain of supermarkets. Moreover, the database will be connected to the central transmitter through a USB connection where it will relay the necessary information to update the prices.

The nature or behaviour of the control software that runs on the central server is flexible and dependent on what the user requires. The simplest way to operate the system is by periodically checking the database for updates to prices. Any changes that are detected can be used to generate control signals to the transmitter which would then send the new information to the individual tags. Software development for operating this can be made simpler through a set of basic APIs that provide fundamental functionality such as changing price by tag identifier or retrieving price by tag identifier.

The central transmitter unit of the AccuTag system will be equipped with a microcontroller, more specifically the Atmega256RFR2[7] which is a microcontroller and transceiver on a single chip. The function of the microcontroller would involve interpreting the information coming from the USB connection connected to the database and relay it to the transceiver. The transceiver on the other hand would send the packets out in a standardized manner and would receive confirmation of reception from the tags located at the shelves.

The tags will be composed of a microcontroller, transceiver, and an E-Ink display. The microcontroller and transceiver used for the prototype will be the same for the tag and transmitter. In our case we have chosen the Atmega256RFR2 [8] RF transceiver. Furthermore, the transceiver on the tag will receive the information from the central transmitter and will relay the packets to the microcontroller as well as sending an acknowledgement signal to the central transmitter for confirming reception of information. The microcontroller will consist of a processing unit which will decode the packet and interpret the message to update the display according. After decoding the packet, the microcontroller will send control signals to the e-ink display to display or update the appropriate information on display.

Hence, the AccuTag system consists of three components namely the database, central transmitter as well as the price tags which interact with one another through RF communication at 2.4 GHz to update and display the product price details with limited manual

2.2 General Requirements

[R2.2.1-A] The AccuTags shall be controlled by a central transmitter unit.

[R2.2.2-B] The AccuTag price tags will display the product price, manufacturer name, manufacturer logo, barcode, weight/volume information as well as any sale information when applicable.

[R2.2.3-B] The AccuTags should be able to decode packets within a radius of 100 m away from the central transmitter.

[R2.2.4-B] The central transmitter should be able to update prices of at most 200 AccuTags.

[R2.2.5-B] The retail price of each AccuTag price tag unit is no more than $26.00 with the price going down with incremental purchase.

[R2.2.6-B] The Accutags shall be designed such that the initial capital cost in terms of shelving and remodelling the supermarket shall not exceed $2000.

[R2.2.7-B] Maintenance costs for the AccuTag system shall not exceed $4000 per year.

[R2.2.8-B] The battery life of the AccuTag system will be between 3-6 years.

[R2.2.9-B] The system once installed will require at most 2 IT professionals to maintain it.

[R2.2.10-B] The database system implemented for updating the price can be regulated through the internet from the headquarters.

[R2.2.11-A] The AccuTags will notify the user to inform of low power by displaying a small battery symbol in the corner of the e-ink screen.

2.3 Physical Requirements

[R2.3.1-B] The AccuTag system shall consist of the Central Transmitter Unit and multiple display units.

[R2.3.4-B] The AccuTags price tags shall be visible to elderly from at least one meter away.

[R2.3.5-B] The AccuTags price tags shall be shock- and water- resistant.

[R2.3.6-B] The AcuuTags price tags shall be properly grounded to prevent any electrostatic discharges

[R2.3.7-B] The AccuTags price tags shall be packaged in a compact and tamper-resistant structure so that they can be securely fastened on to the shelves to prevent unintentional damage or wilful vandalism.

[R2.3.8-A] The AccuTag price tags shall be designed to work with rechargeable batteries that are easily replaceable.

[R2.3.9-B] The dimensions of the AccuTag price tags shall be designed so that the length does not exceed 14 cm, the width shall not exceed 7 cm, and the thickness shall not be more that 3 cm.

[R2.3.10-B] The AccuTag price tags shall be marketed at different sizes and shapes to accommodate various applications.

[R2.3.11-B] The AccuTag price tags shall incorporate photovoltaic cells to convert light into electricity.

[R2.3.12-B] The AccuTag price tags shall use LED light for user notifications such as, item on sale, connection lost and etc.

2.4 Electrical Requirements

[R2.4.1-A] The E-ink display and the transceiver microcontroller board (Atmel ATMEGA256EFR2) shall be powered via a 5V DC supply.

[R2.4.2-A] A USB cable feed through a computer will be used to power the transmitter board.

2.5 Environmental Requirements

[R2.5.1-B] All equipment shall be fully operational from 0% to 90% relative humidity, non-conditioning.

[R2.5.2-B] All equipment shall be fully operational in normal temperature range 0-50^{0}C.

[R2.5.3-A] AccuTag system will replace the paper tags' functionally and eliminate the impact of paper on the environment.

2.6 Design Standards

[R2.6.1-A] The RF transmission module will use the ISM band for communication as they are reserved internationally for the use of radio frequency (RF) energy for industrial, scientific and medical purposes other than telecommunications.

[R2.6.2-A] The design conforms to IEEE 802.15.4 standards[2].

[R2.6.3-A] The device conforms to FCC-Part 15 standards[3].

[R2.6.4-A] The device conforms to the Radio Standard Specifications (RSS)-102 which sets out the requirements and measurement techniques used to evaluate radio frequency (RF) exposure compliance of radio communication apparatus designed to be used within the vicinity of the human body[4].

[R2.6.5-A] The device conforms to the Interference-Causing Equipment Standard (ICES)-001 standards which sets out the technical requirements relative to radiated noise emissions from ISM radio frequency generators [5].

[R2.6.6-A] The device conforms to ISO-15961 standards which deal with radio frequency identification (RFID) for item management[6].

2.7 Reliability and Durability

[R2.7.1-A] All the components are safe to use under normal operating conditions.

[R2.7.2-B] The system shall be serviceable by trained technicians.

[R2.7.4-B] The system shall enter standby mode from 12am to 6am to conserve power.

[R2.7.5-B] The software interface shall be updated periodically to resolve any issues with the database updates and bug repairs.

[R2.7.6-B] The system shall be able to withstand typical day-to-day wear and tear.

[R2.7.7-B] The system shall be resistant to electrical damage.

[R2.7.8-B] The system shall be operated by IT or trained professionals who have obtained the required security clearance.

[R2.7.9-B] The MTBF (mean time between failures) of the AccuTag system shall be no less than 1,000 hours.

[R2.7.10-B] In version 2.0, the central transmitter unit shall be able to track the name, price and location of all price tags in the market and update 200 price tags within at most 5 seconds.

[R2.7.11-B] All hardware equipment except the battery shall last up to 50 years under normal operating conditions.

2.8 Safety Requirements

[R2.8.1-B] There shall be no uncovered pinch points or sharp corners in AccuTag system

[R2.8.2-B] Under normal circumstances, the device shall not overheat or catch on fire

[R2.8.3-B] The device shall not create any interference with other devices.

[R2.8.4-B] The AccuTag price tags shall not cause bodily harm to users under any circumstances.

[R2.8.5-B] The electronic components shall be enclosed in a casing to avoid and harm to user and or the device.

[R2.8.6-B] The device packaging shall display all necessary warnings.

[R2.8.7-A] All the RF transmission is safe for operation within the vicinity of a human body.

2.9 Performance Requirements

[R2.9.1-B]The operating range of the AccuTag system is 100m (i.e. the price update can take place successfully up to a transmitter-tag separation distance of 100m).

[R2.9.2-A]The update of price will take place within 3 seconds of transmission.

[R2.9.3-B] The battery life of the final AccuTag product will be 3-6 years.

[R2.9.4-B] The AccuTag system will be able to update price for 200 tags.

[R2.9.5-B] Same solution for all markets without SW/HW alterations

2.10 Communication Requirements

[R2.10.1-A] Large bandwidth must be available. This allows many separate channels and high data rates.

[R2.10.2-A] 100% duty cycle must be possible.

[R2.10.3-A] More compact antenna solution should be used, below 1 GHz.

[R2.10.4-A] Must conform to IEEE 802.15 standards relating to wireless communications

[R2.10.5-A] The Transceiver shall have an onboard (embedded) debugger to follow the packets received and sent in the registers.

3. LCD requirements

The AccuTag system consists of the E-ink display shield which is an ultralow power-consuming display providing high definition and readability to users. The display shield is shown below in figure 3.1.

Figure 3.1 - E-ink display shield model SLD01093P [1]

This display tag is different from ordinary LCDs and calls for some unique physical and operational requirements outlined in the table supplied by its manufacturer, Seeed Studio.

Item	Min	Typical	Max	Unit
Voltage	4.8	5.0	5.2	V
E-ink Panel Size		2.1		inch
Active Area		2.04		inch
E-ink Drive Ic		SSD1606		mm
Interface Type		SPI		/
View angle		0~180		Deg
Display Resolution		172(H)X72(V)		/
Dot Pitch		0.28X0.28		/
Dimension		68X63		mm
Backlight		---		/

Table 3.1. Specifications and features [1]

3.1 General Requirements:

[R3.1.1-A] The e-ink display shield should be capable of supporting text for 170 languages.

[R3.1.2-A] The library for displaying characters shall be modifiable to accommodate different resolution and font sizes for characters.

[R3.1.3-A] The display screen shall maintain the characters it has both in case of losing connection and power off mode. This is a capability of e-ink displays.

[R3.1.4-A] The display tag shall also be capable of connecting to any electronic shield (supporting SPI protocol and electrical specifications of the tag) via FPC connectors.

[R3.1.5-A] It shall have approximately the same refresh rate as ordinary TFTs.

4. Microcontroller and Transceiver Requirements

[R4.1-A] Provides network support by hardware assisted Multiple PAN Address Filtering

[R4.2-A] Provides advanced Hardware assisted Reduced Power Consumption

[R4.3-A] Provides 32x8 General Purpose Working Registers.

[R4.4-A] Contains non-volatile Program and Data Memories specifically 256K Bytes of In-System Self-Programmable Flash.

[R4.5-A] Provides endurance up to 10'000 Write/Erase Cycles @ 125°C (25'000 Cycles @ 85°C) for the 8K Bytes EEPROM

[R4.6-A] Provides endurance upto 20'000 Write/Erase Cycles @ 125°C (100'000 Cycles @ 25°C) for 32K Bytes Internal SRAM

[R4.7-A] Contains JTAG (IEEE std. 1149.1 compliant) Interface.

[R4.8-A] Contains extensive On-chip Debug Support

[R4.9-A] Master/Slave SPI Serial Interface

[R4.10-A] Two Programmable Serial USART

[R4.11-A] Byte Oriented 2-wire Serial Interface

[R4.12-A] Equipped with advanced Interrupt Handler and Power Save Modes

[R4.13-A] Contains fully integrated Low Power Transceiver for 2.4 GHz ISM Band.

[R4.14-A] High Power Amplifier support by TX spectrum side lobe suppression.

[R4.15-A] Should support Data Rates upto 1 Mb/s.

[R4.16-A] Equipped with -100 dBm RX Sensitivity and TX Output Power up to 3.5 dBm.

[R4.17-A] Contains Hardware Assisted MAC for Auto-Acknowledge and Auto-Retry.

[R4.18-A] Equipped with 32 Bit IEEE 802.15.4 Symbol Counter for application of Packet Sniffing Tool.

[R4.19-A] Provides Antenna Diversity and TX/RX control as well as TX/RX 128 Byte Frame Buffer.

[R4.20-A] At least 38 Programmable I/O lines

[R4.21-A] Operating Temperature Range should be -40°C to 125°C according to Industrial standards.

[R4.22-A] Ultra Low Power consumption (1.8 to 3.6V) for Microcontroller and Transceiver.

[R4.23-A] Ultra Low Power consumption for CPU Active Mode (@16MHz).

[R4.24-A] Equipped with Deep Sleep Mode: <700nA @ 25°C

5. Application/Software Requirements

The computer side software of the AccuTag system consists of three basic components: a small set of basic low level APIs, a price database, and a script that will periodically check for new information in the database then send the prices to the tags.

For our rat's-nest prototype the information in the database will be very basic and not fine grained. Each item will have associated with it, a name, a price, and an information string. The information string can be used to store miscellaneous information, e.g. certain items can have weight, volume, or UPC.

The following are requirements surrounding these three components.

5.1 APIs

[R5.1.1-B] UpdatePriceByID (ID, Price) – API for sending a new price to the price tag to be displayed.

[R5.1.2-B] UpdateNameByID (ID, Name) – API for sending a new name to the price tag to be displayed.

[R5.1.3-B] UpdateInfoByID (ID, Info) – API for sending a new information string to the price tag to be displayed.

5.2 Database

[R5.2.1.-B] Each row in the prices table will have at least the following columns: price tag ID, item name, item price, item information.

5.3 Auto Updating Script

[R5.3.1-B] Will be capable of starting, halting and pausing.

[R5.3.2-B] At start up accepts a list of price tag IDs which it will periodically update if needed

[R5.3.3-B] Check period should be configurable. I.e. how often it checks for updates will be a command line argument

6. System Integration / Test Plan

6.1 Test Plan

Precision Wireless has developed a set of test procedures for testing the device functionality as well as the reliability and usability of the AccuTag system. Since, Precision Wireless is in its early stages of device development, the test procedures prescribed are not final and are subject to technical review given the expected change or adaption to different integration deadlines and requirements. The test plan for the various components of the AccuTag System is discussed in the following sections.

6.1.1 Database Test Plan

The database access test procedure will primarily focus on two aspects, namely the access speed and reliability. A test script will be written to conduct queries on a variety of data types and the measure the time it takes the query to be answered. An average of the access time for a variety of data types is performed. The average access time should not exceed 3s which is the maximum accepted latency of our database system and no data corruption is acceptable.

The reliability of the system will be measured through endurance testing which would involve writing a script to periodically query information from the database for a week and the endurance capability of the database system is measured. For ensuring that the database is highly reliable no outages are acceptable.

6.1.2 Transceiver Test Plan

The transceiver combination i.e. the process of communication between the transceiver in the price tag as well as the transceiver at the central transmitter unit will be tested for functionality and reliability. The functionality of the transceiver combination will be tested for characteristics such as range as well as Packet Error Rate. Since, the Atmega256RFR2 provides us with a guarantee of -100 dBm receiver sensitivity as well as 3.5 dBm output power; test plan for testing of these parameters will be developed as we proceed towards final product design. However, at the initial stages of the product development we plan on using these values as being foolproof.

6.1.2.1 Range Testing

For testing the range of the transceiver combination, we shall use the wireless node without the programming boards. Since, the wireless nodes can confirm reception and transmission through LEDs without the need of programming boards the tester shall confirm to the following test procedures to check the range of the AccuTag system:

1. Charge the AA batteries to full capacity. These batteries are used to power the wireless nodes when they are not on the board. Hence, it is important to ensure full charge of the batteries so as to ensure efficient debugging of the system.

2. Connect the batteries to the casing provided on top of the two wireless nodes and ensure that the wireless nodes are powered on.
3. Finally, the wireless nodes reception and transmission buttons should be enabled and the two LEDs flashing on the board indicate successful transmission and reception respectively. Firstly, the tester shall confirm that the LEDs are flashing at a distance of less than 1m away to move to the next step of the test procedure.
4. This step involves two testers. The two testers should hold the two wireless nodes and shall incrementally increase the distance between them. Furthermore, the testers also need to confirm no presence of any obstructions between them.
5. The testers will now start to incrementally move away from each other with the wireless nodes on hand and will confirm at every instance of incremental distance that the LEDs are flashing. The test will continue until the LEDs stop flashing and the distance between them is recorded.

In such manner, the test determines the maximum range the transceiver combination can communicate across. A range of 100 m is considered the minimum threshold by Precision Wireless for successful test completion of the AccuTag system.

6.1.2.2 Packet Error Rate(PER) Testing

The Packet Error Rate of the transceiver combination is determined with the help of software tools provided by Atmel namely the Packet Sniffer Tool for IEEE 802.15.4 standards. The Packet Sniffer tool allows us to configure the bytes to be sent which we configure to be 127 bytes. Moreover, the tool allows us to look at the received bytes and calculates the PER ratio as well. A standard PER of 0.015 is the accepted level for the AccuTag system, the value determined through review from scientific literature [9] . Hence, the PER testing would involve testing if the PER is below a threshold level of 0.015 for 127 bytes transmitted. The PER testing might be updated as the product development proceeds as more research on industrial standards needs to be determined.

6.1.2.3 Reliability Testing

The reliability testing for the transceiver combination would involve endurance testing. Endurance testing would involve writing an automated script which periodically sends bytes throughout a 12 hour period. The Packet Sniffer tool is also enabled to track the flow of packets. The reliability testing should ensure that bytes have been continuously received and sent throughout the 12 hour period when appropriate power is provided with a maximum PER of 0.015. Furthermore, when endurance testing the range should be maintained at a standard range of 1m (i.e. the transceiver combination should be separated by a maximum distance of 1m).

6.1.3 Microcontroller Testing

Microcontroller testing of the AccuTag system would involve testing the firmware. Since, functionality of the microcontroller at the central transmitter side compared to the microcontroller at the price tag side differ they shall be tested independently.

For the microcontroller at the transmitter side, it has to receive information from the database through the USB, check that the information received is in the standard format and transmit the information to the transceiver for transmission. Hence, the primary job of the microcontroller is relaying messages in the correct form to the transmitter while rejecting messages that do not follow the pre designed form of a message. Precision Wireless has determined the standard of the message i.e. how many types of messages can be relayed, the specific compositions of the message as well as the standardized contents of the message. Hence, the microcontroller job is to filter the standard message from the junk and notify the database accordingly. Thus the testing of the microcontroller firmware on the transmitter side will consist of the following steps:

1. The tester shall ensure that the application connecting database to USB generates 40 messages of correct form and 40 messages of incorrect form and relay it to the transmitter.
2. The tester through the use of Packet Sniffer shall confirm that only the 40 messages have been transmitted.

The standard tolerance level determined by Precision Wireless for the AccuTag system is 100% filtering i.e. all 40 messages in proper form are transmitted and 40 messages in improper form are rejected.

The functionality of the microcontroller on the price tag side is fundamentally different from the microcontroller at the transmitter side. The microcontroller at the price tag side, decodes the messages received and determines from the tag identifier in the message if the message is directed to the specific price tag and generates the control signals for display in LCD. Hence, the testing of the microcontroller would involve the following steps:

1. The tester shall make sure that the transmitter sends 40 messages with 5 seconds interval in between each message. Among the 40 messages, 20 messages will be directed at updating the price tag while other 20 will be directed at updating other price tags. The 20 messages sent to LCD in testing shall be varying types (i.e. shall result in a different display every time)
2. The tester through Packet Sniffer as well as LCD display shall confirm that all 40 messages were received by the Rx Buffer while only 20 updates were seen in the LCD. An interval of 5s is sufficient to determine if the update has taken place with success. The standard tolerance level determined by Precision Wireless for AccuTag system is 100% filtering i.e. all 20 messages directed at the price tag result in update of price display and 20 messages not directed at the specific price tag are rejected.

6.1.4 E-ink Display (LCD) Testing

Since, the LCD component is used only for display; the testing will ensure that all characters in the ASCII standard table [10] shall be displayed. Hence, the tester shall ensure all characters in the ASCII table can be displayed on the e-ink display. The standard tolerance level determined by Precision Wireless for the AccuTag systems is 100% i.e. all characters should be displayed.

6.2 System Integration

Once, the individual testing of each components namely the database, transceiver and e-ink displaay is completed, system integration would involve connecting the components as shown in the figure below. The Central Transmitter(Central server in the figure) will interact with the database application through USB connection, while the LCD and the tag will communicate through SPI/ISP.

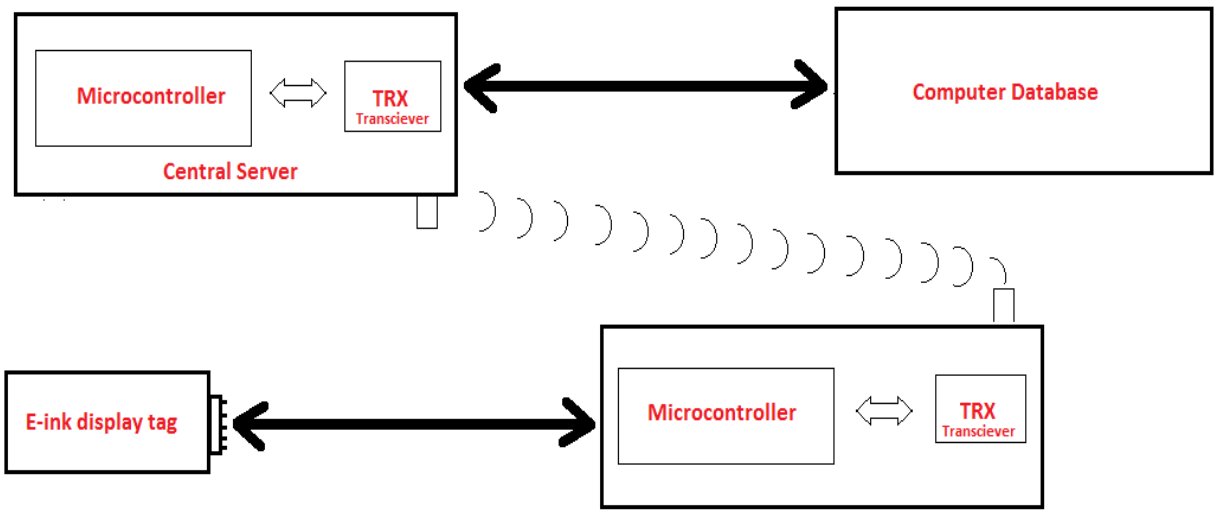

Figure 6.2.1: Figure Illustrating the integrated AccuTag system

6.2.1 System Testing:

System Testing for Accutag version 2.0 would require at least 20 tags and a central transmitter unit with the database system properly functional. System testing for the whole AccuTag system would involve the following steps:

- The tester shall upload the standard price tag catalogue designed by Precision Wireless for 20 tags in the database.
- The tester shall execute send instructions on the database Application thereby enabling the central transmitter unit to send information.

- The tester shall ensure that all 20 tags have been updated with the information as specified in the price catalogue.

The tolerance defined by Precision Wireless for successful system testing is 100% i.e. all 20 tags should be updated with the accurate information without fail.

7. Conclusion

This document clearly and succinctly outlines all the requirements that the members of Precision Wireless believe are most important for us to deliver in our prototype and final product. This specification will be used by our team as the development process proceeds to gauge whether a certain feature or component can be considered and whether said feature is important enough to invest time in. We are confident that all these requirements will be met when we present our final prototype during the demonstration in December.

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