Final Thesis

MS –Telecommunication and Networking

A Simulator Prototype for Integration of RFID and Sensor Networks

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Dedication

I dedicate this to those who spread peace with help of Islam and those who try to make smile on the faces of poor and needy people and also to my loving parents.

A Thesis Submitted To

Department of Graduate Studies and Applied Sciences
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As a partial Fulfillment of Requirements for the Award of the Degree
Of
MS in Telecommunication and Networking

Declaration

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Acknowledgement

All Praises for Allah the all Mighty Praise be to God (ALLAH), the Cherisher and Sustainer of the Worlds (Rabbul Aalameen), Most Gracious (Al-Rehman), Most Merciful (Al-Raheem) and Master of the Day of Judgment, whose bounteous blessings enable us to pursue and perceive higher ideas of life. He is he, who sent his prophets for the guidance of Human beings and Ginns. Darood and Salaam upon his last prophet, Muhammad (Peace be upon him), his family and his companions, who has the ultimate and eternal way of complete success for this world and the hereafter in the form of Quran: the vital demonstration of ALLAH's grace to man, the vital knowledge, and the vital beauty of appearance: in short, the word of ALLAH. After this I would like to mention about my parents whose courage and moral give me a deep support during my entire academic career that enabled me to complete my work dedicatedly. I would like to thanks to my respected teacher's and my friend Muhammad Tayab (Faculty member HITEC University Taxila) who gave us their precious time and full support to complete this thesis work. I also would like to say gratitude to my truly friends especially "the prayer (Nemaaz)" that helped me in every difficulty. I once again would like to mention that I pay all my accomplishment to my most caring parents who mean most to me, for their prayers are more valuable than any wealth on ground. May they all live long with special and unlimited blessing of Allah (Subhana hu Wata'ala).
Ameen Ya Rabbul AaLameen.

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Thesis in Brief

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Undertaken By:	Jehangir Khan (01-244082-033)
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Abstract

RFID (Radio frequency identification) and WSN (Wireless sensor networks) are the two key wireless technologies that have a large number of uses in present and upcoming systems. RFID is a wireless automated recognition technology which is primarily used to recognize objects or to follow their position without providing any sign about the physical form of the substance. On the other hand, WSN not only offers information about the state of the substance and environment but also enables multihop wireless communications. Hence integration of the promising technologies of RFID and WSN increase their overall functionality and capability and give a novel outlook to a wide variety of useful applications. As per literature survey no simulator is available for the integrated environment of RFID and WSN. In this thesis, a simulator has been developed that integrates both RFID and WSN technology. An application scenario has been run in order to test the functionality of RFID and sensor networks. Further an integrated RFID tag with a sensor node has been communicated with the base station/end system.

INTRODUCTION

Chapter 1 Introduction

In future computing technology is expected to interact with the physical environment through small wireless and communication devices. In this regard the RFID (Radio Frequency Identification) and WSN (wireless sensor networks) are the most promising technologies for emerging the real and virtual world. RFID which has the ability to identify and track the objects with its unique code provides information about the presence or absence of the object. Similarly the WSN make use of sensor nodes to gather and process information about the physical environment which results in to calculate the state of the object. Both these mentioned technologies are implied separately in a number of applications like asset monitoring, public transportation, supply chain, controlling building access etc. By emerging, the two promising technologies will result in a number of useful applications enhancing their capabilities and effectiveness. Such step towards the integration of the two technologies has been made in the study to envision the simulation environment of RFID and WSN. This study will help a lot in understanding the real scenarios of the integration and will highlight some attractive areas for research community.

1.1 Radio Frequency Identification

RFID (Radio frequency identification) is a wireless automated identification technology that has the capability to accumulate and recover data through electromagnetic communication using radio frequency readable integrated circuit [1]. This technology is termed under the group Automatic Identification (Auto ID), such as bar code, magnetic stripes, biometrics (voice, finger printing, and retina scanning), smart cards, voice recognition, optical character recognition etc [2]. But RFID system not only enables the feature of unique identification for tracking objects but overcomes the challenges of the above mentioned identification system because the object to be scanned need not to be in line of sight with the reader, preserves tough physical milieu, maintains a cost and power-efficient operation, and allows for simultaneous tag identification. An

RFID system typically consists of these main parts: A set of tags, a reader, an application host

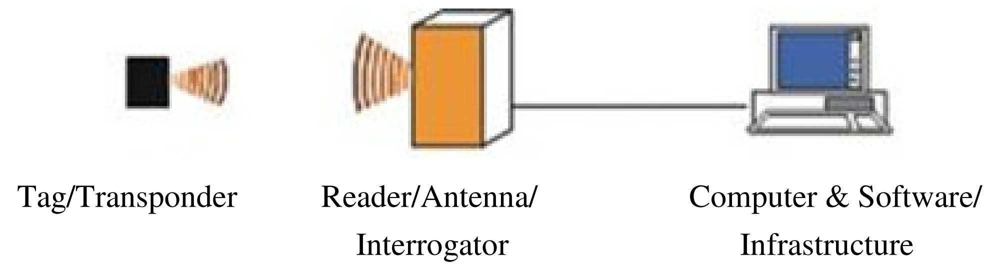


Figure 1.1: Overview of a RFID system [3]

The interrogator antenna radiates a field of electromagnetic waves, which provides a means of communication between the RFID tag and reader. The tag absorbs the radiating energy and power up its microchip to backscatter the signal including the tag unique identification number. The reader then updates a background system about the presence of tagged item in the range which usually runs software that stands between RFID readers and applications. This software is known as RFID middleware.

1.1.1 Frequency

The RFID operating frequencies band is divided into four major classes: “like Low Frequency (LF) 125 KHz – 134 KHz, High Frequency (HF) 13.56 MHz, Ultra High Frequency (UHF) 315 – 433 MHz, 865 – 956 MHz” and 2.45 GHz and Microwave Frequency 2.45 GH [4].

Based on these frequency bands the communication range greatly depends upon factors like “the operating environment, the detail of the antenna design and the available system power” [5].

1.1.2 Tag-Reader Communication

Tag-reader communication is handled by common procedures often specified in RFID standards such as the “ISO 15693 and ISO 18000-3 for HF or the ISO 18000-6 and EPC for UHF” [6]. Tag-reader communication process is initiated by the reader once it is power on. The reader broadcasts signals at a special frequency band. Corresponding tags within the reader’s range will absorb the signal energy to power up their internal integrated circuits. The tags then respond to the reader after decoding the signal as valid and continue RF transaction indicating its presence.

1.2 RFID System Components

Typically RFID systems have three main components: Tag, Reader and Application Host.

1.2.1 Tag

An RFID tag (also referred to as a "transponder, smart tag, smart label, or radio barcode") has a unique identification number (ID) and memory that is designed to store certain unique information (such as "manufacturer name, product type, and environmental factors including temperature, humidity, etc".) about the physical object to which the tag is attached, the size of which varies between 32 bits and 32,000 bytes. This tag attached to any physical object can be read and/or written wirelessly with the help of a reader to ascertain its identity, position, or state. The tag consists of a "silicon chip or an integrated circuit" and an antenna. The silicon chip holds an inimitable recognition number and the antenna can launch and take delivery of radio waves. These two components are typically attached to a smooth plastic card which can then be attached to any substantial object. The physical size of a tag can be quite small, thin (like a grain of rice) and can be easily embedded in items like plastic cards, tickets, clothing labels, books etc [18].

1.2.2 Reader

The reader also refers to as interrogator or scanner may have a number of antennas that accounts the process of sending and receiving RF data to and from tags wirelessly [8]. The readers may be deployed stationary or as mobile to notify or energies the tags to "wake it up".

1.2.3 Application Host

The host computer responsible for processing the received data form the reader to obtain some useful information after mapping between IDs and objects via consulting a background database.

1.3 Types of Tags

RFID tags have been classified into a number of categories based on the power source, memory type and wireless communication signal. Each of these classifications is mentioned below.

1.3.1 Tags by the power source

Based on power source, Hai Liu et al [9] classified RFID tags into three major classes: “active tags, passive tags, and semi-passive (semi-active) tags”.

1.3.1.1 Active Tags

These tags contain its own power resource that supplies the power to the radio transceiver and on-board circuitry. These tags have more powerful processing power than the rest of tags. These tags can communicate with readers in a distance of 100 meters or more. They can respond to low power signal form RFID reader than other tags. Due to its advanced processing power these tags can also be set for incorporated sensors for reporting environmental factors such as temperature, humidity etc. Active tags have a significant amount of memory than passive tags and are best suited for environment where a number of tags need to be read simultaneously. However, these tags are a bit more costly than the passive/semi-passive ones and have a finite battery life which must be replaced periodically.

1.3.1.2 Passive Tags

A passive tag does not use any power source of its own. It utilizes the same signal for appending information as a power source and contains a low power integrated circuit. This integrated circuit is attached to an antenna. With the help of this antenna the tag collects electromagnetic energy from the reader transmitted signal which induces a current in the tag antenna. This current wakes up the tag circuit that reflects a piece of the energy reverse to the transceiver adding information to the reflected signal with the help of modulating. These tags have power only when in communication with an RFID reader. Generally the low power constraint restricts these tags to a short read range up to 3 meters or less. This restriction also results in small amount of memory which can store manufacturer unique data in the range of 64 bits. However these tags have much longer life cycle because they require energy only for its processing operations which is utilized from the received signal. These kinds of tags are cheaper than powered tags because of their nominal involved circuitry. These types of tags are more suitable for applications of individual products such as super markets checkouts and smart cards.

1.3.1.3 Semi-passive Tags

Semi-passive tags are set with energy source to sustain information in the tags or energized some supplementary tasks. This category of tags utilizes the radio waves of source as a power source for their communication like the other passive tags. But this category of tags are having more reliability and larger communicating range than pure passive tags because more power is available for other purposes. Only its life cycle get reduced due to its dependence on battery source and results in an expensive range than other passive tags.

Generally the terms “Semi-passive” and “Semi-active” are used interchangeably in literatures.

1.3.2 Tags by the memory type

Another classification of RFID tags is based on memory type, tags with read/write memory, and tags with read-only memory.

1.3.2.1 Read only Tags

RFID tag with read/only memory is programmed once by the manufacturers and cannot be modified later after. As usually a limited size of static information can be stored so are easy to integrate with a data collection system. Generally these tags are cheaper than others.

1.3.2.2 Read/write Tags

This class of tags performs both types of memory operations. The information on the memory can be altered dynamically after the manufacturing process. These tags can store larger amount of information (usually in the range of 32 Kbytes to 128 Kbytes) than Read/only tags but are quite expensive and is impractical for applications of inexpensive items.

1.3.3 Tags by the wireless communication signal

Another classification of RFID tags is based on the technique of wireless signal used for exchange of information among the two nodes of commnication. i.e. (Near field RFID and Far field RFID)

1.4 Wireless Sensor Network

WSN (Wireless Sensor Network) is a communication technology that has the ability to observe things in the vicinity of concentration, sense the environment and work out for the essential information like "temperature, humidity, pressure, vibration intensity, sound intensity, power-line voltage, chemical concentrations, pollutant levels, etc" and continuously send that sensed information to the main station. Sensor networks are composed of sensor nodes that sort out their selves into a multihop arrangement and are organized in the area of interest like "on the ground, in the air, in vehicles, inside buildings, or even on human bodies" for getting the required information for the user. Every node has got sensors, implanted processors, some low-energy circuits, and in generally is battery functioned. Usually, nodes are organized to carry out a common assignment. To transmit data to a sink, sensor deployed in the area judge the atmosphere, collect the updated information and put forward through other deployed nodes to the base station that normally is far away from the data source. As this technology do not facilitates a long range communication because of the narrow energy of sensors, support from multihop wireless connectivity is taken to forward and receive data to and from distant sinks. The whole scenario is depicted in Figure1.2.

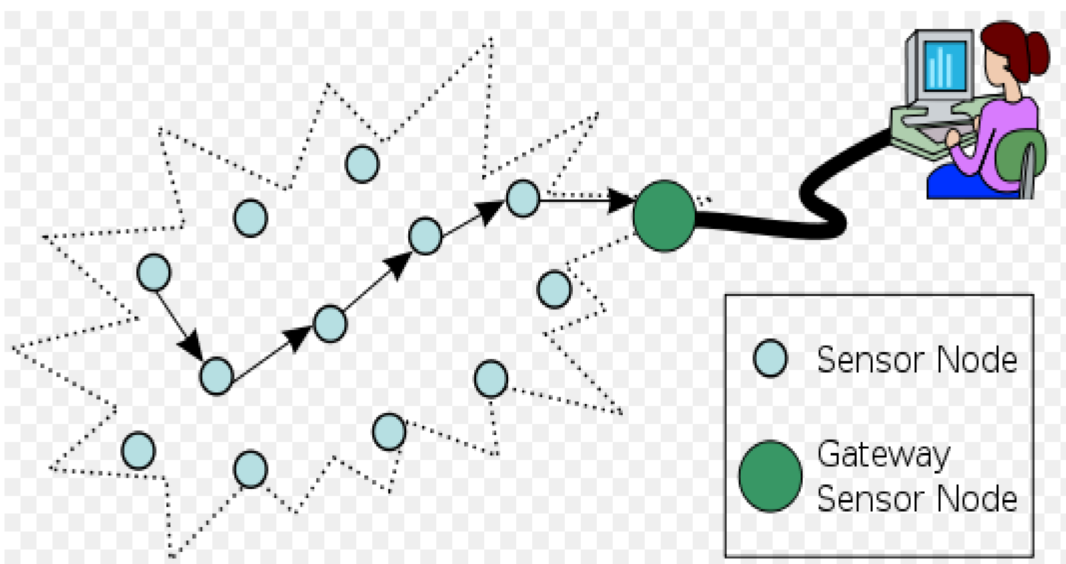


Figure 1.2: Overview of a Wireless Sensor Network [10]

1.4.1 Sensor Node

A senor node also known as mote has the ability to collect information and communicate with the rest of associated nodes in the network [11]. Usually a sensor node composed of a transceiver, hardware to sense, storage memory, power supply and a processor. A common node along with its parts is shown in Figure1.3.

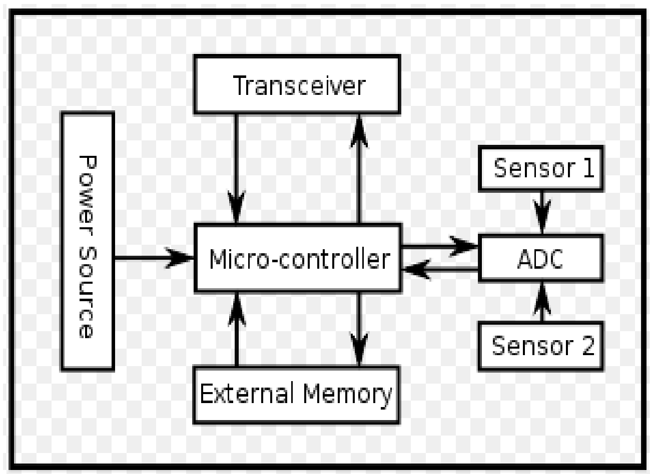


Figure1.3: Components of Sensor Node [12]

Normally a sensor node occupies a very low volume in size. The different types of nodes used for research are mica2, micaz and micadot etc. The mica2 mote has got a shape of rectangular block, with size 2.25 × 1.25 × 0.25 (in inches), weights about 18 grams as shown in figure1.3, the mica2dot mote have circular shape with size 1.0 × 0.25 (in inches) and weights 3 grams.

1.5 Why Integrate RFID and WSN

The integration of RFID and WSN technology will enhance the capabilities and functionalities of each other. A broad range of useful advantages can be achieved by merging them into each other because both technologies represent two complementary to each other.

Few of them are listed below.

- RFID labels are less costly as compared to sensor nodes; it is reasonable to use RFID tags to swap some of the sensor nodes in WSNs.
- RFID technology can be used to track objects that otherwise are difficult to detect.

- WSN can provide RFID system with a variety of good judgment capabilities to produce intelligent RFID tags.
- In WSN environment, RFID system can be made capable of operating in multihop fashion (Adhoc netwok) that potentially will extend the applications of this technology.
- Flexible retrieving of information can be achieved by avoiding the wired communication with the base station by make use of portable readers.

1.6 Difference between RFID and WSN

WSNs are normally deployed to observe objects in areas of interest or to sense environment while RFID systems are used to detect presence or absence of objects that have RFID tags. A summary of both technologies in Table 1.

As both the technologies are equally opposite to each other and the effectiveness of broad range useful applications are just a step ahead with the merging of two technologies.

Table 1 WSN vs. RFID Systems [13]

Attribute	**WSNs**	**RFID Systems**
Purpose	Sense parameters in environment or provide information on the condition of attached objects`	Detect presence of tagged objects
Component	Sensor nodes, relay nodes, sinks	Tags, readers
Standards	Zigbee	EPC Protocol architecture
Communication	Multihop	Single-hop
Mobility	Sensor nodes are usually static	Tags move with attached objects
Power-Supply	Battery-Powered	Tags are batters-powered or passive
Programmability	Programmable	Usually closed systems
Price	Sensor node--- medium Sink--- expensive	Reader --- expensive Tag --- Cheap
Deployment	Random or fixed	Fixed, Usually requires careful placement
Design goal	WSNs are general- purpose	Tags are optimized to perform a single operation, such as read

Literature Review

Chapter 2
Literature Review

2.1 Initial Work

Many studies related to the integration of RFID and WSN are considered in adequate at [14]. L. Zhang and Z. Wang, proposed three types of integration namely heterogeneous network architecture, integration of reader and WSN node in one device and smart tags having limitations to be applied over large area, due to requirement of long cable between reader and antennas.

Jongwoo sung et al. [15] investigate the current research and limitations in the field of RFID and Wireless sensor networks and suggest the idea of a large-scale infrastructure which will be based on the standard EPC network architecture. The proposed architecture was planned to be a entirely accurate infrastructure in future.

By considering integration of RFID and EPC global- based RFID technologies J. Mitsugi et al. [16] proposed four reference models for integration.

- "A mix of RFID and WSN whose integration is at the application level
- Mix of RFID and WSN with the integration at the filter and collection level,
- Integration at hardware level where tags and WSNs data are collected by a RFID reader ,
- Logical integration at the EPCIS level that allows for a mix of RFID and WSNs."

Without taking into account for integration, S. Cheekiralla et al. [17] sub classified communication, power, memory, sensors to propose taxonomy of wireless sensor networks including RFID devices.

Beiwei Zhang et al. [18] discussed three general and one novel composite network architecture. They target RFID sensor network systems that utilizes distributed network architecture of smart nodes and to read tags through smart nodes it consider the MAC protocol with the Basic Frame Slot Aloha (BFSA). They also analyze that the energy consumption of the smart nodes is mainly due to the receiving of data from tags and relaying. Firstly, for smart node to read tags in its reading range they use BFSA protocol as the MAC protocol, and compute the energy consumption then the WSN energy model is utilized for the computation of the smart node's energy of relaying data. Finally the lifetime of a smart node is also assessed.

Hai Liu et al. [19] discussed four types of the integration of the RFID with sensor networks these are, integrating tags with wireless sensor nodes, integrating readers with wireless sensor nodes and wireless devices, and mix of RFID and sensors. According to their investigation the powered RFID tags like the semi-passive or active RFID in combination with WSN has a promising future because it expands its applications in terms of broad reading range. Further, the new RFID chipsets from other manufacturing parties like Intel will decrease the cost of RFID readers in UHF range as well. Thus due to the use of powered RFID technology and low price reader will allow stationary employment of the readers in the same manner like a WSNs can be organized. Similar the ability of multi-hop communication of sensor networks can be utilized to take out information from the readers.

Luca Catarinucci et al. [20] present a a cost-effective general purpose multi-ID tag, called S-Tag, that can be connected to generic sensors, and is capable to transmit a proper combination of ID codes depending on the actual value at its input. They connect S tag to various types of the sensor and validate its suitability. They present and demonstrate the outcomes related to the application of the S-Tag in very stressing conditions. The very easy and simple interfacing to generic sensors, a compatible to the typical RFID technology and low price solution make the S-Tag a good nominee for enhancing the capabilities of RFID-based telemedicine systems.

Antonio Ferrer-Vidal et al. [21] present an overview of a better performance UHF radio frequency identification tags and implanted sensors and power batteries.

They investigated that substrates like an Organic one, e.g a paper which has been very infrequently utilized in UHF and RF applications in the previous times could potentially utilize inkjet printing techniques that is necessary for the realization of ultralow- cost RFID/Sensor tags for frequencies ranging from 13.56 MHz up to 950 MHz for the first time ever. Additionally they use of implanted rechargeable thin film batteries will also enlarge the nodes' lifetime. They also investigate that use of compact dual-polarization antennas operating in the UHF/RF bands will enable a high read range with high data rate transfer.

Luca Catarinucci, Riccardo Colella, et al [22] propose a cost-effective general-purpose multi-ID tag, that can be connected to generic sensors, regardless of the actual measured value, that is capable to transmit, when interrogated by a standard RFID reader, a proper combination of ID codes that univocally codifies the sensor measured value. They present the Results related to the application of the S-tag in very demanding situation have been presented, representing the high-quality concurrence between transmitted and received data. Moreover, examples of the use of the S-tag in very simple wireless sensor networks for temperature and humidity remote control have been reported and its good performance highlighted.

Ze Li et al. [23] discussed how helpful and effective it will be when RFID and WSN have been combined together. They also discussed about some applications of this integrated technology in the field of precious animal and patient health monitoring where real time information is of utmost importance. They introduce a system structure of the integrated RFID and WSN and the simulation results showed that the new system outperforms traditional RFID monitory system in terms of the cost of deployment, updating delay and tag capacity requirement. They narrate the system as Hybrid RFID and WSN System (HRW) to integrate the RFID and WSN technology, which overcomes their disadvantages and puts their advantages to a good cause. The major advantage is that Instead of waiting each tags being read by the RFID readers, the information in HSNs can be replicated among its neighbor nodes based on a special reduced functional RFID readers in HSNs.

Sajid Hussain et al. [24] presented the integration of radio frequency identification and wireless sensor network in smart homes and applications of the system such as identifying a caregiver who entered the home. Then they proposed an architecture consisting of RFID, a WSN to identify motion within an environment and who is moving as well a several useful applications which can take advantage of this information. When WSN and RFID are combined, they can be used to create a system that is ideal for deployment in a smart home. Their Proposed architecture has many possible applications that can be implemented in software with little or no hardware changes.

Bolivar Torres et al, [25] used the Synapse Network Evaluation kit, which included the two sensor nodes. The software consisted of a program module developed in Python to control the microprocessors of the nodes; and a database controlled by a simple program to manage the tag IDs of people wearing them. The WSN and RFID nodes were connected through I2C interfacing. Also, the work of sending commands to the RFID node, to make it read a tag and send it back to the computer, was accomplished by the Python code developed which also controls the data signals. Their research had the potential of being adapted for use with secure real-time access control applications involving WSN and RFID technologies.

Rohit Pathak, Satyadhar Joshi et al. [26] proposed software framework for RFID integrated mobile phones with considerable changes in the system is exemplified. They also discussed Installation of the operating system with a driver to run RFID reader and involvement of Java Platform ME package for support in programming for RFID reader. Proposed Scheme system service continuously watched over the RFID hardware for events. Standalone application made in Java can also use and control the RFID reader. Exemplary future applications and systems based on RFID and other technologies integrated with RFID mobile phones were also proposed.

Daniel Patrick Pereira et al, [27] presented a proposal of two heterogeneous architectures for integration between technologies WSN and RFID. For this study was presented with a model of Non deterministic pushdown automata (NPDA), which made their validations, through its states and transitions. This model represented the set of states sensor node and add on RFID transceiver. Then were defined: the language, alphabets and their evidence of recognition of words through its configuration instantly. The next step of their work included the proposal of models that can better represent the behaviors of the system .They also aimed to develop extension to the current model, wanted to add communicating among automata, so that they can better represent the system as a whole and from the scene to check the properties of the system: liveness, boundness, reachability among others.

Tomás Sánchez López and Daeyoung Kim [28] proposed a frame work for RFID and WSN integration in order to offer context aware services to users and objects. Their contribution in the integration of RFID and WSN constitutes a significant work in which sensor and RFID data merge to build dynamic context, and in which the designed architecture around the context proved to be compatible with the current EPC Network infrastructure. They propose a practical implementation scenario for both real and simulated Wireless Sensor Network, Web services and EPCIS-like repositories. They also mentioned some software tools for monitoring and evaluating their algorithms.

Hai Liu et al. [29] investigates recent research work and applications that integrate RFID with sensor networks, four classes of integration were discussed: "integrating tags with sensors, integrating tags with WSN nodes and wireless devices, integrating readers with WSN nodes and wireless devices, and a mix of RFID and WSNs".

Some other attempts were performed in different articles on the integration scenarios for WSNs and RFID in various applications, including health care, supply chain management, managing cattle, condition of weapons in battle field, fire detection etc

2.2 Road to proposed Solution

Thus many attempts and approaches are carried out on the integration of two technologies (Radio frequency Identification and Wireless Sensor Networks) but applications to the integrated simulation environment are kept avoided in all attempts and approaches.

Problem Statement

Chapter 3
Problem Statement

3.1 Problem Definition

The integration study of RFID and WSN will pose some significant challenges for the researchers when the integrated environment is composed of a large number of RFID and WSN components. To deal with such problems simulation environment is needed to provide detailed analysis of application scenarios, to speed up the developing and testing process and minimize the cost and interference.

In this regard both the RFID and WSN technology have got a number of simulators like (QualNet, OPNet and SENSE, TOSSIM) RFID ("BL Ident Configurator", “RFIDSIM”, “NS-2”, “Matlab”, “Labview”, etc) but there is still a room for the development of such a simulator that combines WSN and RFID technology.

3.2 Objectives

In the field of RFID and senor networks integration, the simulator design needs the attention of researchers from many aspects but my research focused on the following four objectives.

1. RFID Tag Generation
2. Tag energizing/de-energizing
3. Data collection
4. Tag/sensor data collection and providing to base station

PROPOSED SOLUTION

Chapter 4
Proposed Solution

4.1 Proposed Solution

The primary goal for implementing a simulator is to accomplish the tasks of this thesis presented in Chapter 3, i.e. RFID Tag Generation, Tag energizing/de-energizing, Data collection, Tag/sensor data collection and providing to base station.

In this study a simulator has been developed that has the capability of developing an RFID tag and senor nodes by applying simple commands from the GUI interface provided by the simulator. This developed RFID tag has been used for integration with a sensor node. After which the integrated RFID tag and Senor node has been communicated with the base station to exchange the retrieved data obtained from the environment. Furthermore the simulator provides different interfaces for checking the tag state, commands implementation (Energizing and De-energizing) and randomly data obtaining. The general proposed scenario is shown below.

4.2 Obtaining Components

The following important components considered for the proposed solution are

1. RFID Tag Generation
2. Tag energizing/de-energizing
3. Data collection
4. Tag/sensor data collection and providing to base station

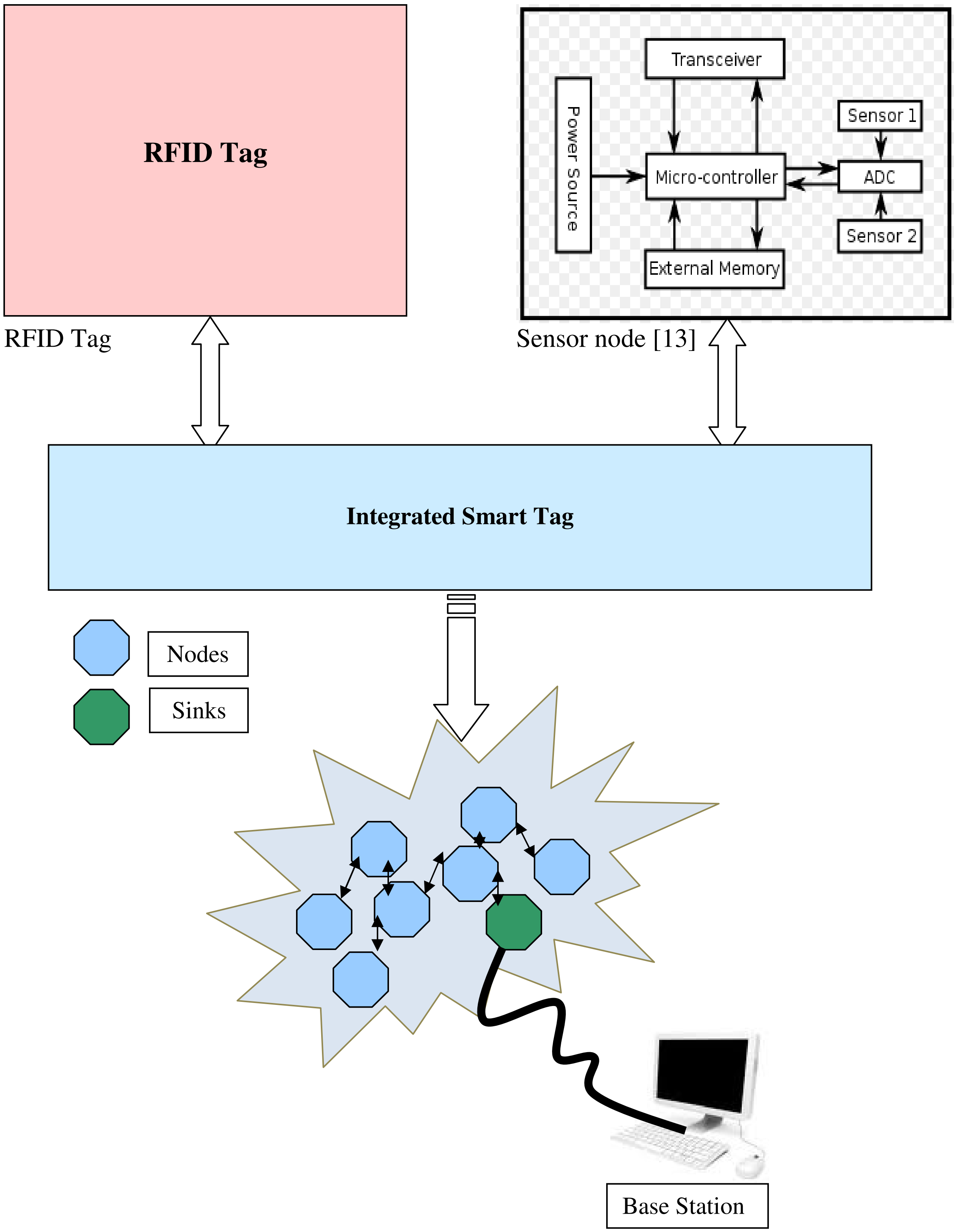


Figure 4.1: Proposed solution of Simulation Architecture

SIMULATION AND RESULTS

Chapter 5
Simulation Details and Results

5.1 Simulator Development Process

Conceptually as shown, the design is organized around a set of coupled modules. Each module contains a set of related classes, which in turn, are listings of programming code and software simulation that contain the essential instructions for creating, manipulating and integrating tags and nodes of a given application scenario.

The general architecture layout of the design is shown below.

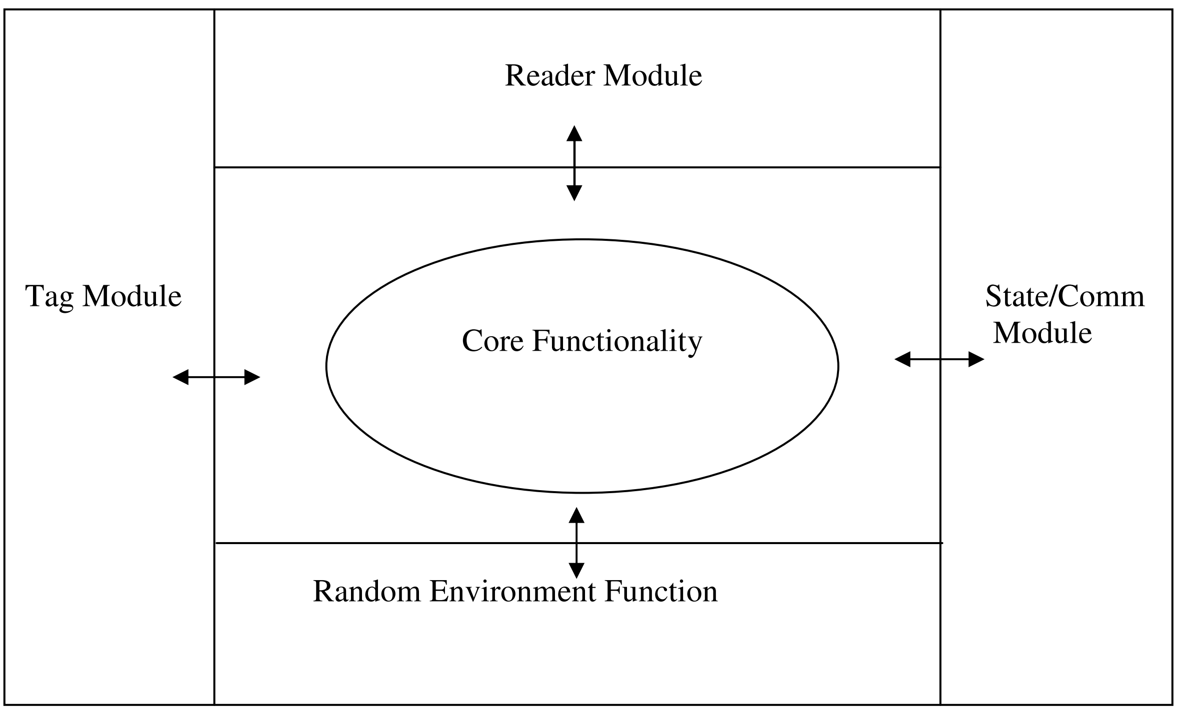


Figure 5.1: General layout of Simulation Architecture

At the topmost level, the simulator code is designed and constructed around a simple architecture, as shown in the figure.

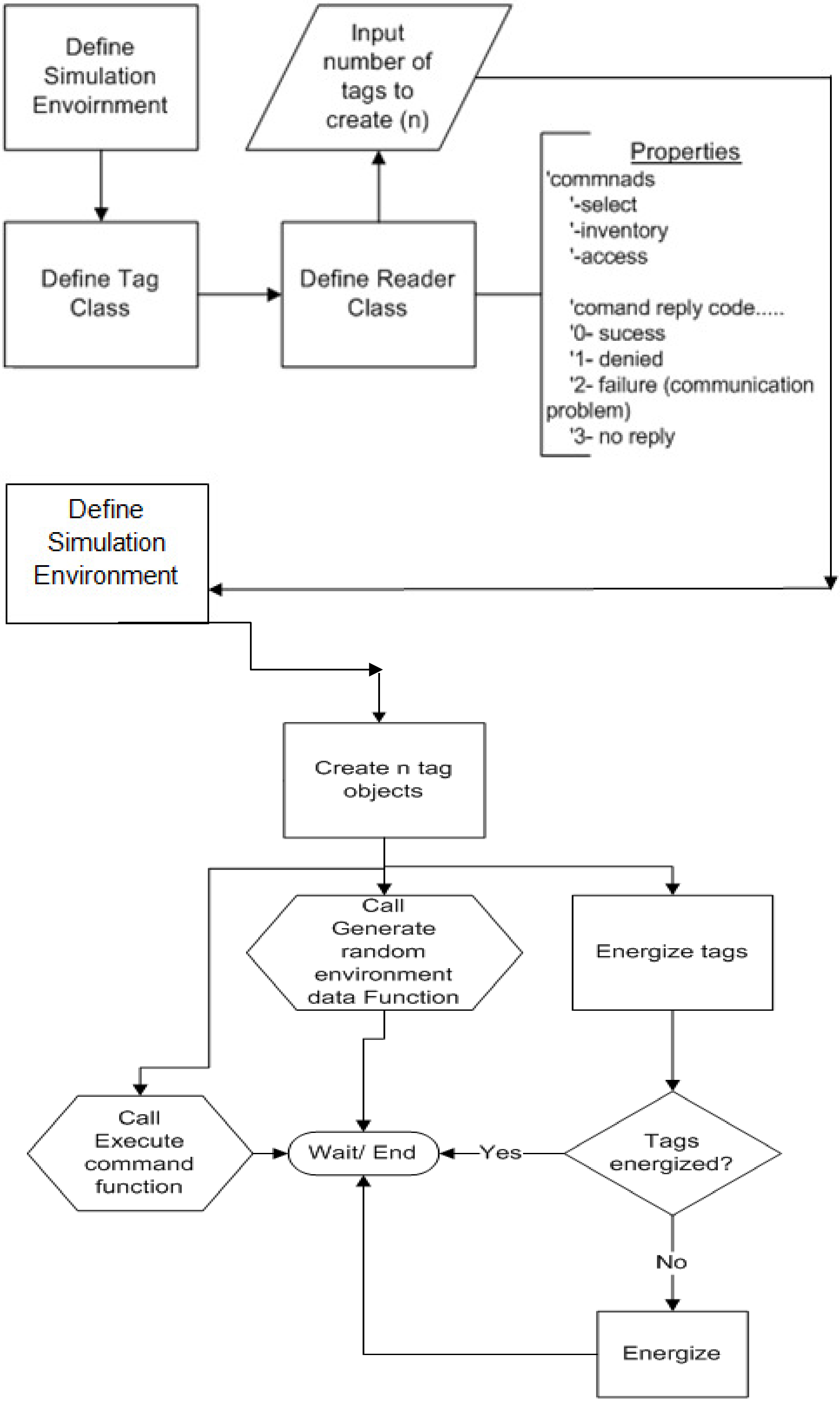


Figure 5.2: Process layout of Simulation Architecture

In the above diagram the general interface packages for tag, reader, random environment data function and energizing/de-energizing function are shown.

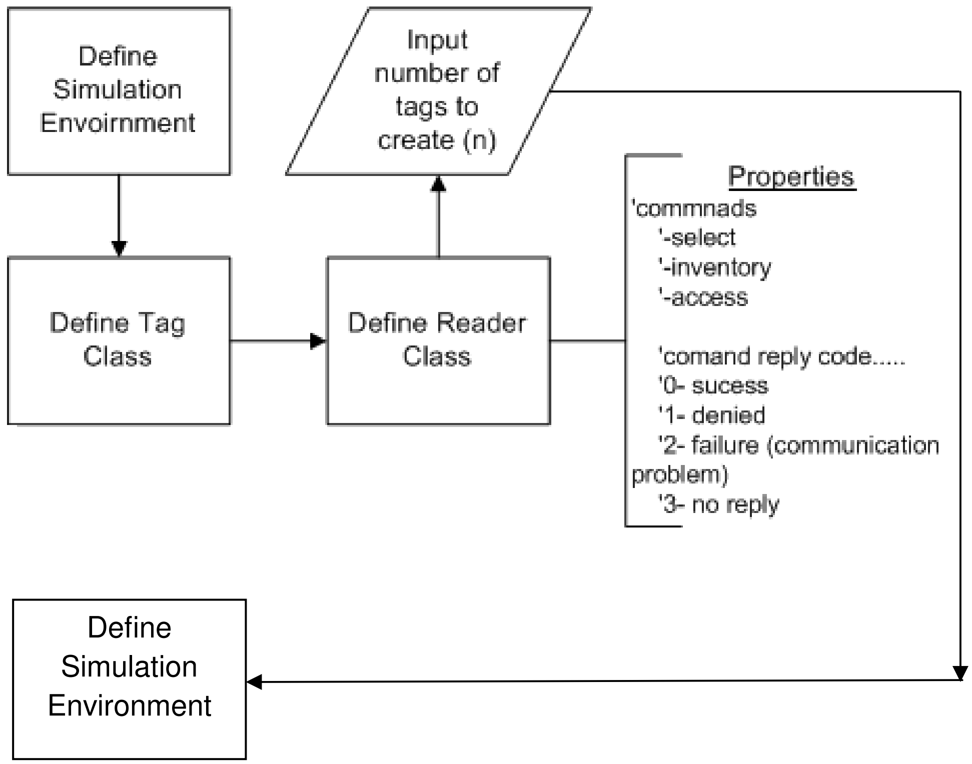


Figure 5.3: Layout of Tag/Reader input interface of a RFID system

This module defines the different parameters of a tag and reader. i.e the EPC manager, object code, object class and unique identification number. Some of the predefined electronic product codes tag standards are shown in the table.

The EPCglobal EPC Tag Data Standard identifies the specific encoding schemes for

- The EAN.UCC Global Trade Item Number (GTIN)
- The EAN.UCC Serial Shipping Container Code (SSCC)
- The EAN.UCC Global Location Number (GLN)
- The EAN.UCC Global Returnable Asset Identifier (GRAI)
- The EAN.UCC Global Individual Asset Identifier (GIAI)
- The EAN.UCC General Identifier (GID).

The EPC tag standards are determined by their header. The following are a few of the defined header standards:

Table 2: EPC Header Standards

Header Bits	Encoding Standard
11001110	DOD-64
11001111	DOD-96
00110000	SGTIN-96
00110001	SSCC-96
00110010	GLN-96
00110011	GRAI-96
00110100	GIAI-96
00110101	GID-96

In our approach the General Identifier (GID-96) has been used as the encoding standard for the generation of the tag.

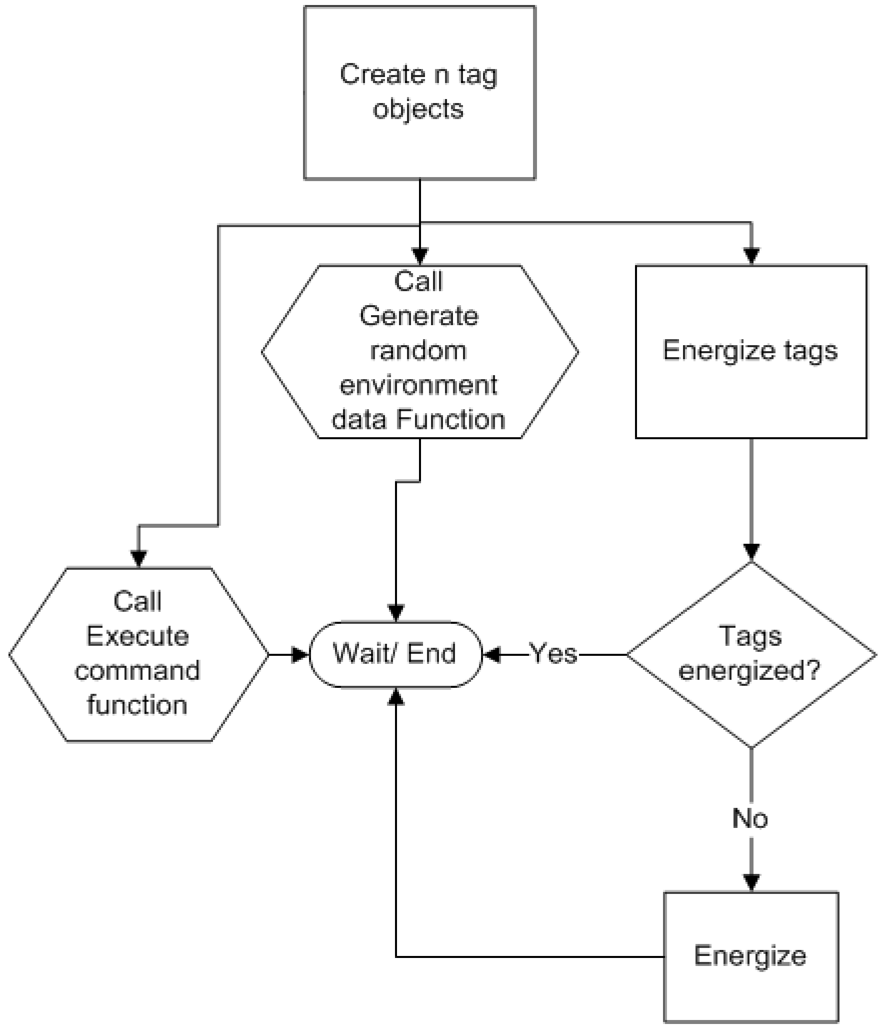


Figure 5.4: Layout of Random and state function interface

The generated tags after the specification of different parameters are energized in order to facilitate further processing. This tag can only then operate with further sensor nodes and with environment. This whole process is depicted in the above diagram.

Currently our design will perform on only static application scenarios but are expected to become more fully developed in future versions of the program.

5.2 Simulator Design

The main components of that we design for our proposed simulator is as follows in the figure 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11 and 5.12.

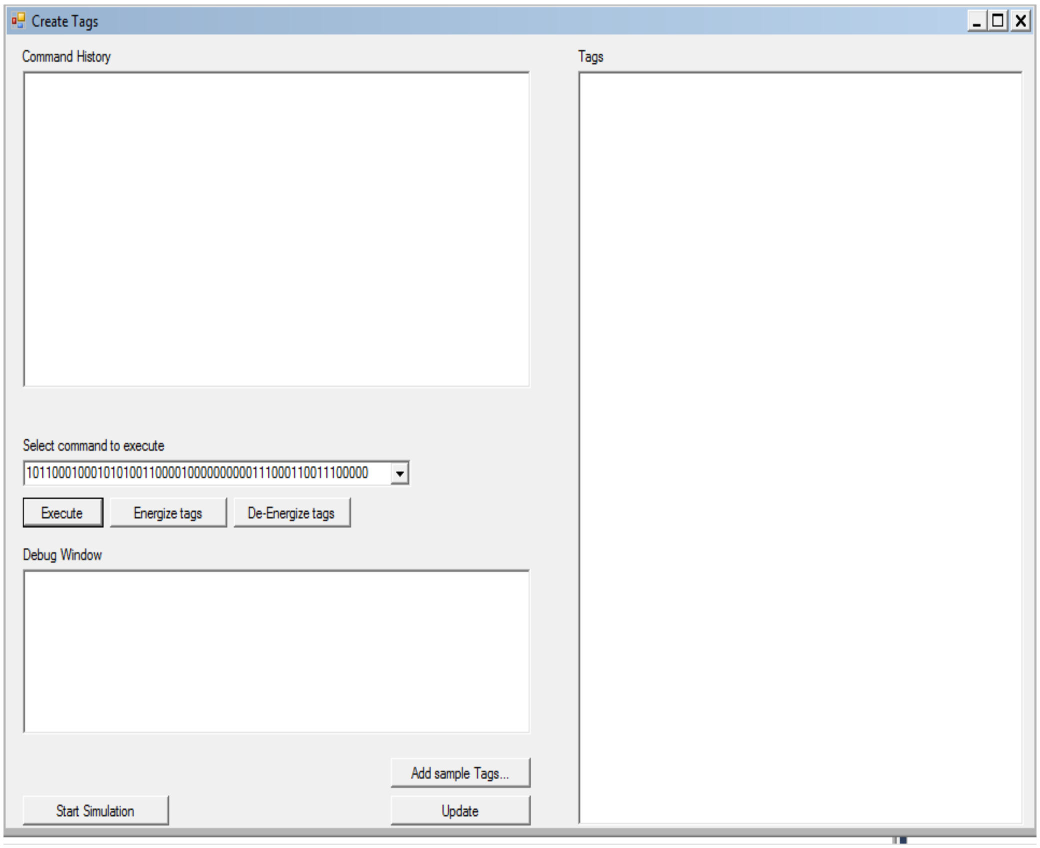


Figure 5.5: Simulator main GUI

- Create new tags
- Energize or De-energize tags (Changes the state of the tag)
- Test tags by sending them sample commands

5.3 Tags Generation and State

The generation of tags is simply performed by specifying its strength (Number of tags). Our designed automatically define its EPC Manager, Object Code, Unique identification number, header and its Tags states. It does simply provide a GUI interface for such operations. Following are the layouts of the different GUI interfaces.

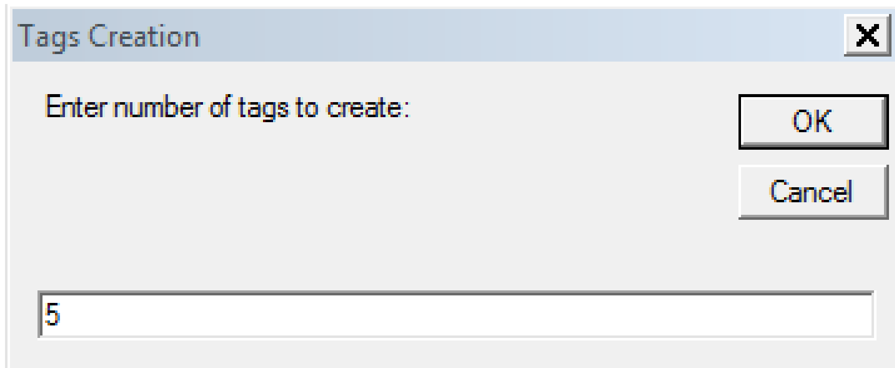


Figure 5.6: Specification of number of tags

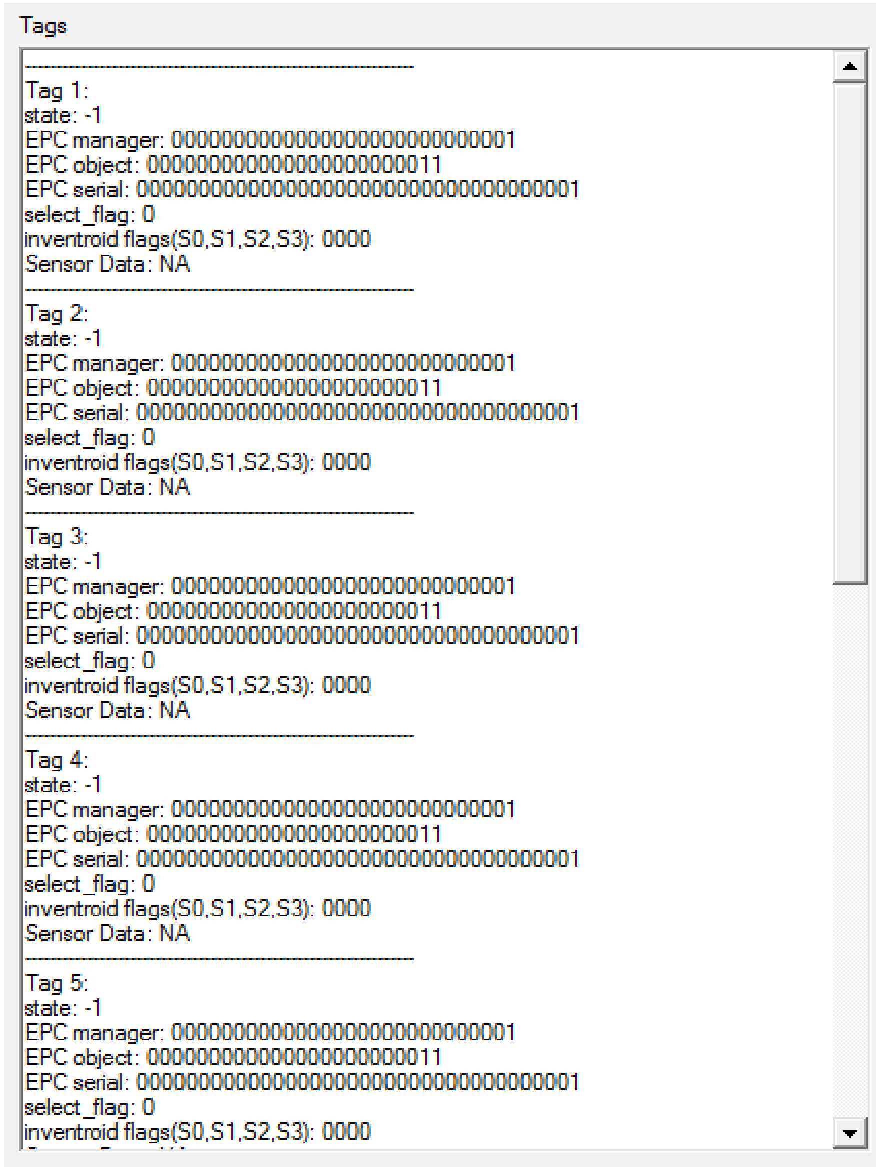


Figure 5.7: Specified Generated Tags

- Generated Tags
- Tags states, EPC, SEL flag, INV flag and Sensor data
- Random environment data for sensor

✓ **De-energized Tags** (Represented by their state as (-1))

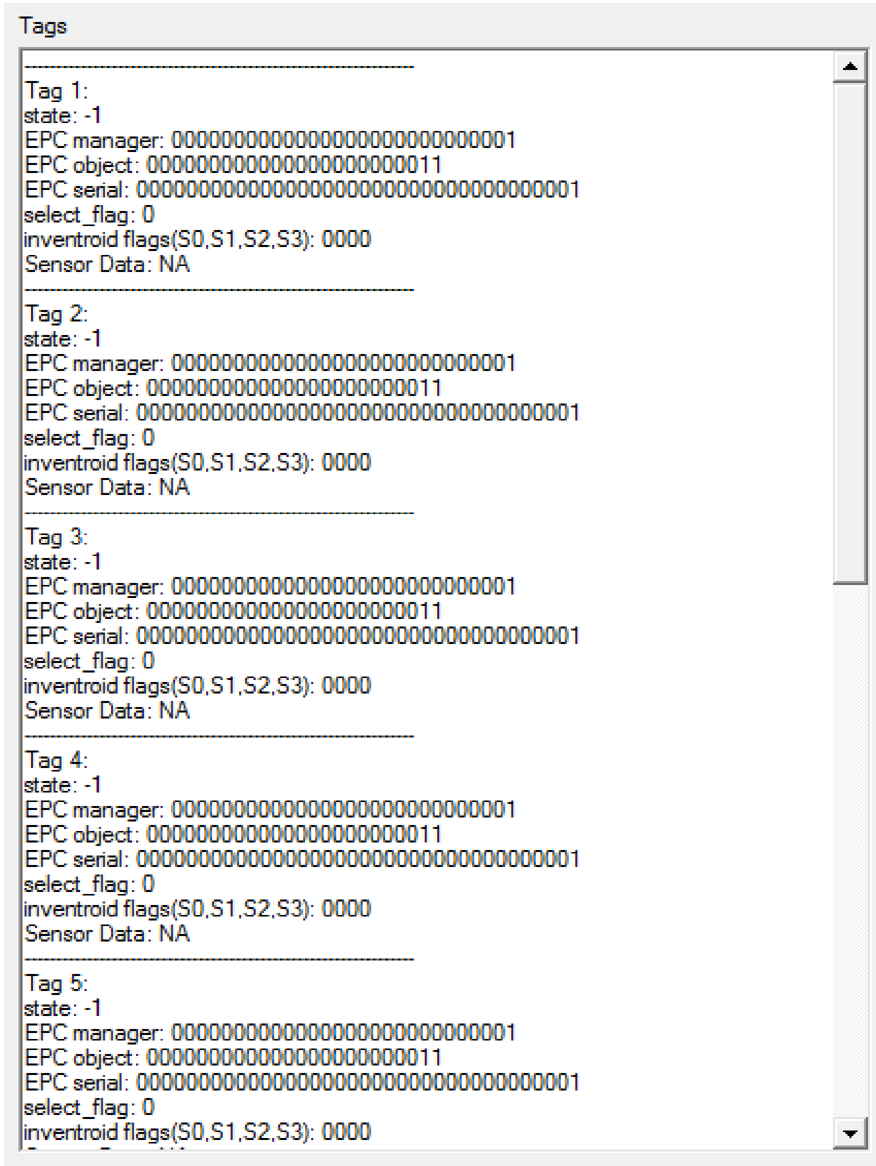


Figure 5.8: New created tags with their tag state as de-energized

✓ **Energized Tags** (Represented by their state as zero (0))

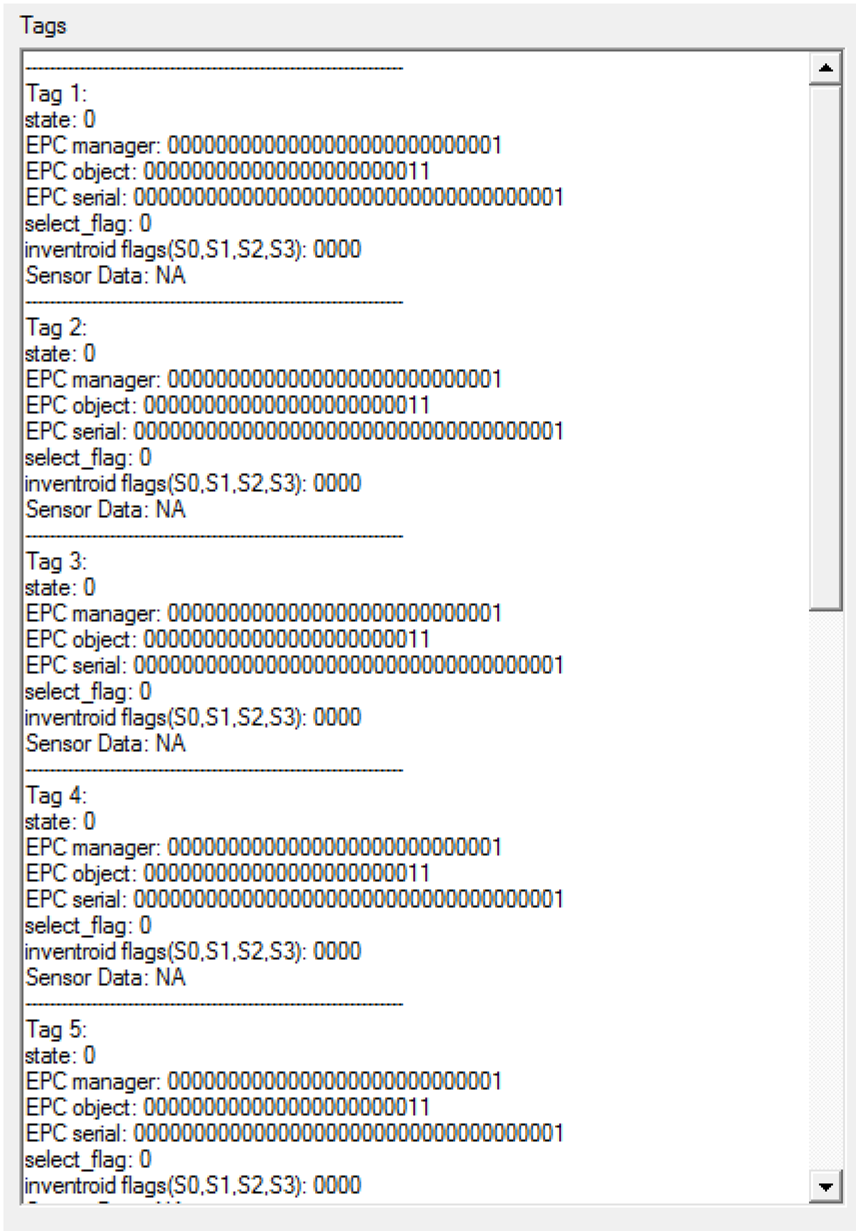


Figure 5.9: Tags with their tag state as energized

5.4 Tag Processing

✓ **Tag Processing Window**

- Sensor data to base station
- Based on RFID communication

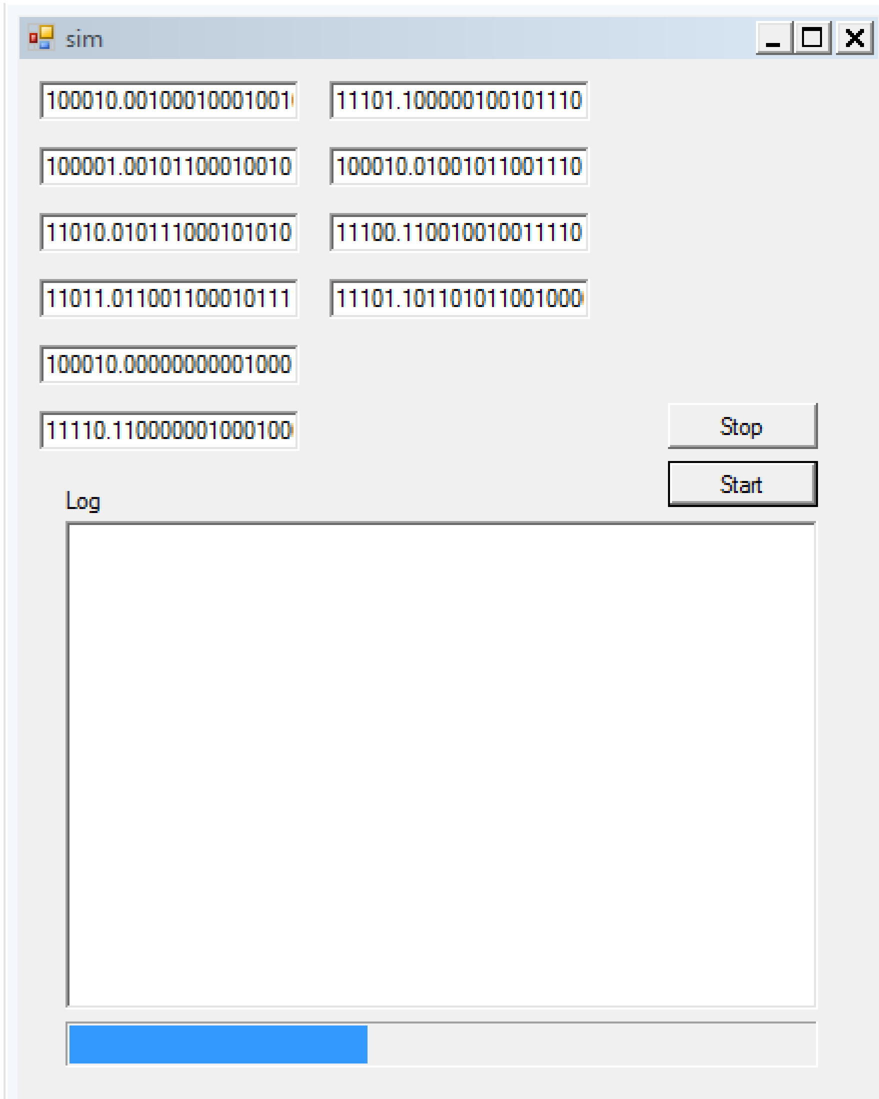


Figure 5.10: Tags Processing window

5.5 Simulation Results

✓ **Simulation Results Window (1)**

- Active, Passive and AdHoc links
- All smart nodes with Base station
- Randomly distributed nodes
- Data routed through AdHoc links

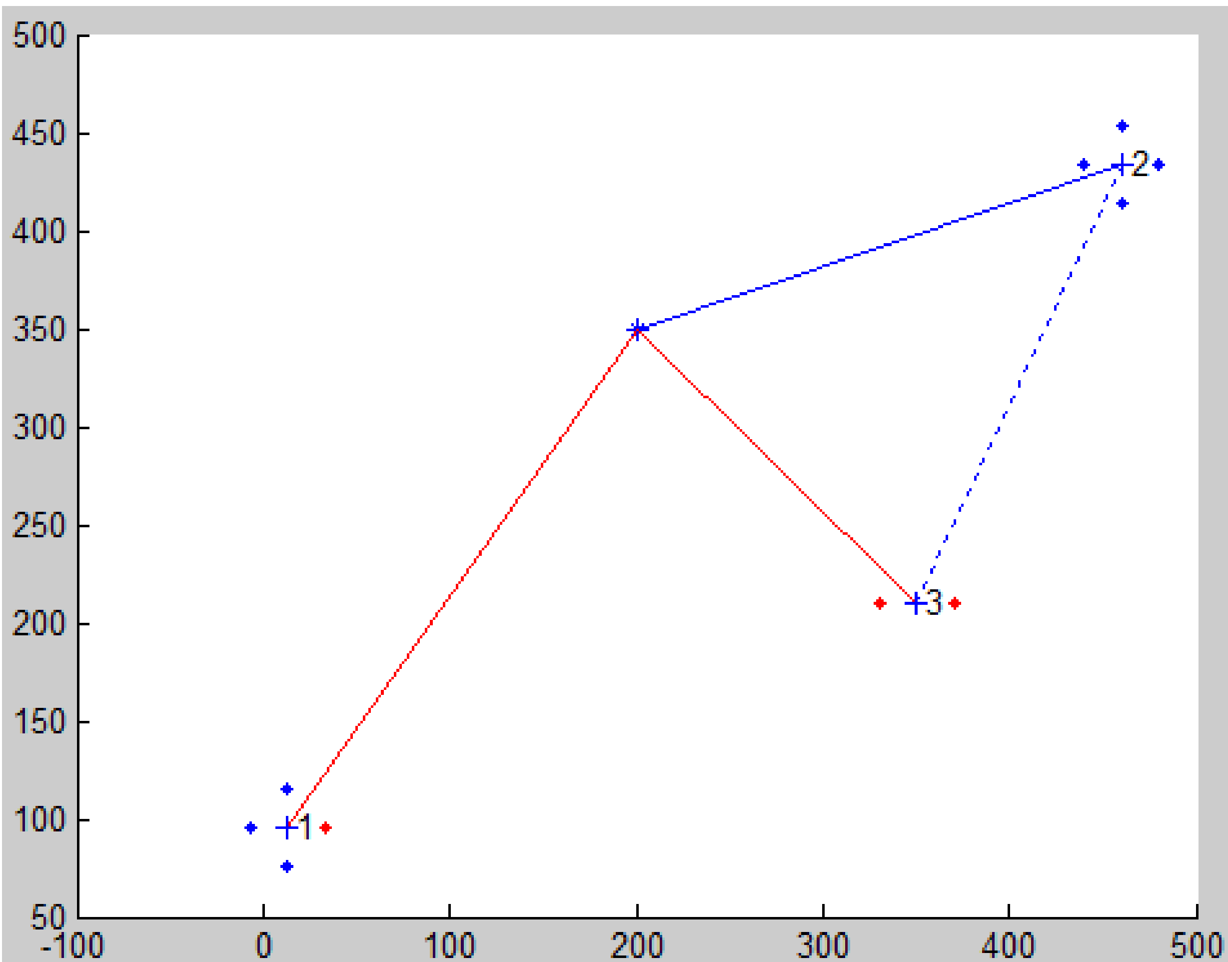
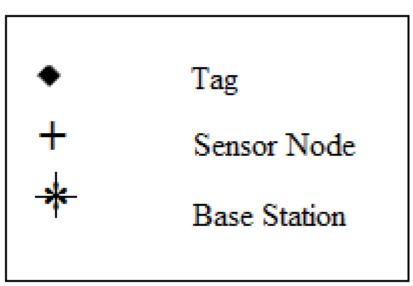


Figure5.11: Simulation Results window (1)



✓ **Simulation Results Window (2)**

- 100 different samples received from each tag
- Natural distribution of random data is shown

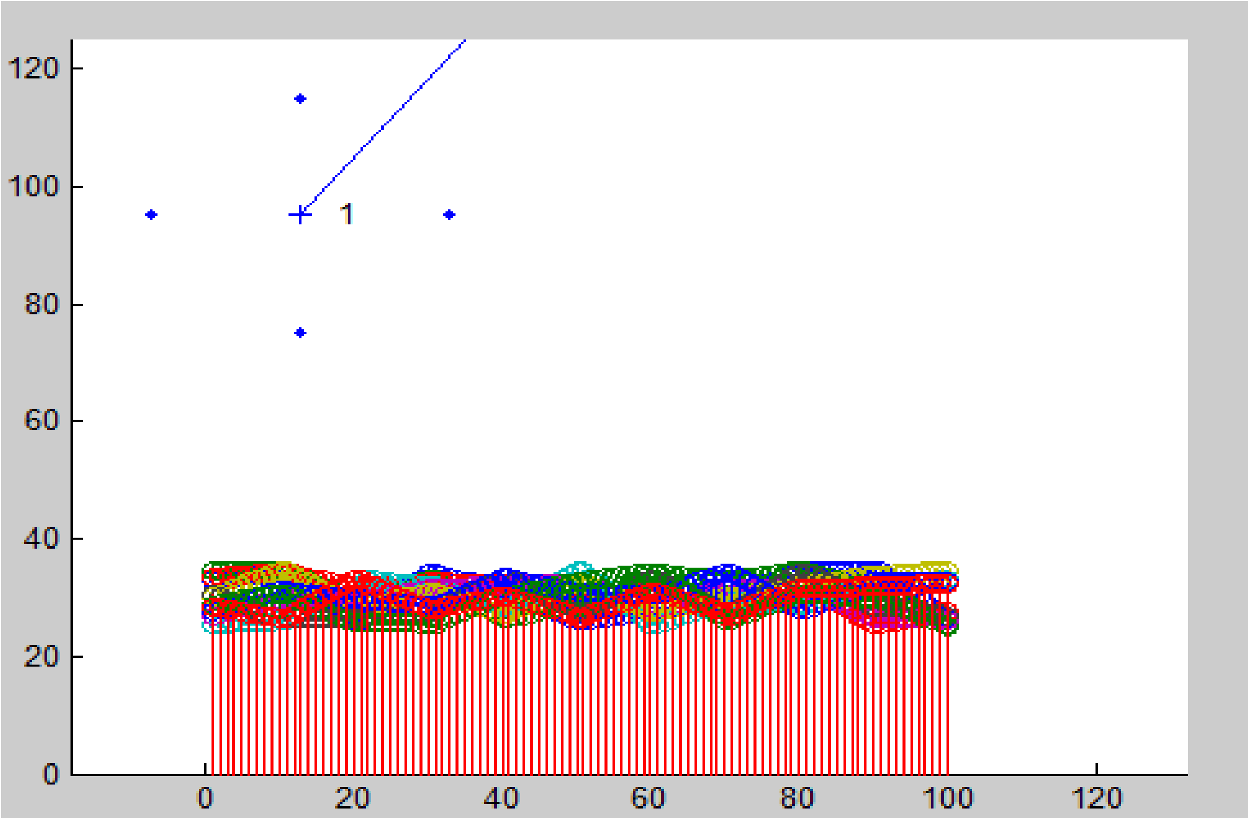


Figure5.12: Simulation results window (2)

CONCLUSION AND FUTURE WORK

Chapter 6
CONCLUSION AND FUTURE WORK

6.1 Conclusion

In this thesis, we have proposed a simple and reliable design of a simple simulator for RFID and sensor networks. This proposed design provides a GUI for easily generating of tags and sensor nodes. Our designed automatically define its EPC Manager, Object Code, Unique identification number, header and its Tags states. This design contains four different Components that are RFID Tag Generation, Tag energizing/de-energizing Data collection and Tag/sensor data collection and providing to base station. This intelligent design has reduced the overall development of this vital component of RFID tag and sensor node which ultimately results in less development time and minimum cost.

6.2 Future Work

In future we need to enhance the Software for dynamic applications scenarios and environment. Currently steps will be made towards the routing capability and low power consumption of a RFID tag and WSN sensor node.

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