Volume 2 No.8, AUGUST 2011 ISSN 2079-8407
Journal of Emerging Trends in Computing and Information Sciences

http://www.cisjournal.org

# An RFID based E-commerce solution for the implementation of secure unattended stores

[1]Athul Rathore , [2]Raul Valverde
[1]University of Liverpool, [2]Concordia University
[1]athul.rathore@my.ohecampus.com, [2]rvalverde@jmsb.concordia.ca

## ABSTRACT

The present research concentrates on automation of retail process that involves customers. One can save on total man power required to manage a physical retail store and store tills if RFID at item level is implemented in a retail store. One can reduce number of persons at Security / Payment till required at store counter and exit. Although RFID can automate and reduce human errors at payment counters.
A commercial transaction takes place the moment a customer (buyer) reaches the store exit gate. The proposed solution implemented will cut down operational cost for retail stores and a business can pass the benefit to customers. It will ease customer shopping by extending shopping hours in retail physical stores. The work that has been carried out to produce a conceptual system that implements and integrates a RFID based message system with existing transactional based E-commerce applications. The research conducts a comparative overview of the various technological frameworks, together with transaction and data transfer. The researched and the applied architecture for the proposed prototype system minimize changes on the existing applications and network design. The results of the experiment using a prototype are analyzed. The study concludes with the reviews and considers how the issues highlighted may be addressed in order to achieve an improved framework through discussing possible solutions. The prototype system has been successfully developed. With the prototype one can achieve objective of unattended store. The tests have demonstrated that it is possible to make such system with required security, reliability and scalability.

**Keywords**— *RFID, E-commerce, Unattended stores, Security Systems*

## I. INTRODUCTION

The business automation with the evolution of E-commerce on the Internet has advanced exponentially in recent years. It is driven by information and wireless technologies. The emergence of cost effective wireless RFID is a new way of tracking and implementing business processes and security. It is going to bring a huge degree of confidence in business process automation. This is going to affect the way we do business now.

In a virtual (internet) shopping a buyer selects items and proceeds for payments with few clicks on an internet browser. In the proposed solution a buyer physically in a store pick up all the items (RFID tagged) to be purchased and put it in a shopping basket. Then the buyer proceeds to check out exit. At this moment local RFID receiver system will register all the items with the customer. The RFID system integrated with internet based E-commerce system calculates the total payment and ask buyer to authorize the payment by entering his password on a key pad. This completes the payment and in general completes an E-commerce transaction. The above solution allows a physical store application to be integrated with E-commerce application to make it a complete 100% unattended store.

The scope includes design of a RFID based intelligent system that integrates with an E-commerce application in an unattended store. The proposed research lead to a system that will identify a person and items using RFID tags allocated to each person and items. Then a system initiated trigger mechanism will initiate a transaction as required by business application. The transaction will include sell of an item from physical store without presence of a cashier at physical till (unattended store). The system will use online payment gateway using E-commerce technology for payment authorization and order confirmation.

The research lead to design and development of an independent module called as Real Time Security System (RTSS). The above concept can be used in many other applications that involve electronic transactions. For example how to monitor and control premises security using the system for unattended buildings or premises.

A prototype is developed to prove the feasibility of the concept. The prototype scope includes design of a RFID based intelligent system for E-commerce in an unattended store. It identifies a person at check point of a store or an office. The research lead to a system that identifies a person and items using a RFID tag allocated to each person and items. Then a system initiated trigger mechanism initiates a transaction as required by business application. The transaction includes sell of an item from physical store without presence of a physical till and a cashier at till (unattended store). The system uses an online payment gateway through E-commerce application for payment authorization and for order confirmation.

## II. RESEARCH METHODOLOGY

The Research Methodology involves qualitative research that involves design of technical artifacts with a 'physical' realization (i.e., RTSS prototype software)[1].

The qualitative research methodology on RFID integration with E-commerce application is directed towards "theory building" and contributes to the advancement and use of the RFID knowledge in the society. To a certain extent, this kind of RFID integration research is conducted and seems to be feasible based on level of maturity in RFID and E-commerce technology. The above said qualitative research lead to development of a hypothesis for 'Is RFID integration with E-commerce and Security Applications feasible? If yes then how it can be achieved? And what technologies can be used?'. The research provides available information, further details and possible solutions (proposed hypothesis) for above research questions. The hypothetical developed methods in theory has to be proved for their practical feasibility. The hypothetical developed method followed by system development is 'proof-by-demonstration' type support for the proposed hypothesis. The proposed qualitative research is close to action research because method for RFID integration with E-commerce and Security Application is developed and evaluated in a social context. The action research for RFID integration aims to contribute both to the practical concerns of people in an immediate situation within acceptable ethical framework. Further the action research approach is a constructive where existing RFID and E-Commerce knowledge is used to produce a useful system including design and development of prototypes and processes.

The proposed research project is not an applied research. The applied research targets a specific problem relating to the introduction or functioning of an information system. As of now the 'RFID integration with E-commerce and Security Applications' in this respect is not closer to practice. The result of this research is intended to help and mature the RFID integration to a level so that practitioners in future do their job better.

The above research methodology leads to building a theory that involves discovery of new integration knowledge and its use in the RFID and E-commerce field. After the RTSS theory is proposed it needs to be tested in the real world to show its validity and to recognize its limitations, as well as to make appropriate refinements according to the facts and observations made during its development using design methodology.

Testing is conducted in more or less natural settings with actual RFID devices and E-commerce application. For RTSS prototype testing mix of both interpretive and pseudo-scientific approaches are applied. An interpretive testing provides a more flexible setting for RFID applied exploration without any predefined "dependent and independent variables, but focuses on the full complexity of integration with E-commerce for human sense. The prototype experimentation of RTSS requires a certain level of control over some of the variables under consideration at least to the extent that independent, dependent and controlled variables are predefined during the research design stage.

The proposed RTSS theory leads to the development of a prototype system with the intention of illustrating the theoretical framework. The 'RTSS prototype systems' demonstrates the effective design, delivery, use and impact of RFID and E-commerce integration technology in organizations and society[2].

The Object Oriented Analysis and Design (OOAD) principles are used to develop the proposed concept in support for proof-by-demonstration. Prototype is developed based on evolutionary model. Each research / validation cycle as described in the previous section produces something to be evaluated and the result is usable in next research cycle. Thus each research cycle improves the proposed design.

The RTSS model will have various modules. The module coupling will be through control coupling unlike normal applications that have data coupling. The control coupling provides an advantage of implementation of new findings as and when required. Further the component based architecture will be used that is a non trivial, independent and replaceable part of a system that fulfills a clear function in the context of a well defined architecture. For OOAD technique the system requirements are mapping of system 'behavior' obtained from research methodology. The software and system design is captured from the 'model' build during design methodology. The high level and low level design in OOAD will include following diagrams.

The research on RTSS system development as an integration methodology confirms the following five criteria:

a) The purpose is to study an important phenomenon of integration of RFID with E-Commerce in areas of information systems through system building,
b) The research results make a significant contribution to the domain of RFID use,
c) The RTSS system is testable against all the stated objectives and requirements,
d) The new RTSS system can provide better solutions to business automation problems than existing systems, and
e) Experience and design expertise gained from building the RTSS system can be generalized for future use.

The above research and design methodology will lead to logic with a design concept and a prototype development.

## III. LITERATURE REVIEW

RFID is an "always on" technology, continually generating signals for a system to communicate. It is not necessary to know the low level technicalities to understand the principles, considerations and potential for

using RFID. However, a little technical appreciation can provide advantage in determining system requirements.

From the analysis of literature we can conclude that RFID is not an operational transaction-based system. The RFID concept is about messages. The interrogator and transponder exchange messages. And it could be about thousands of messages coupling RFID interrogators into an existing application [3].

Today RFID and its use have following open challenges that have to be accepted and agreed for commercial use in business. RFID data has electronic product code (EPC). EPC standards are still pending. EPC tag data standard is being defined by EPC Global. EPC Global is formed from Software Action Group and Uniform Code Council (UCC) [4].

It is important to note that not all RFID interrogators (as devices) are supported by a given operating system. The Linux and Windows are the main operating system that most RFID supports.

There are some challenging disadvantages of RFID. The performance degradation because of metallic or other conductive materials environments may affect use of RFID for many businesses that involve such environment. The Tags performance for tags located on or near liquid products is not encouraging for businesses that need high accuracy and good response for transaction.

The RFID equipments are susceptibility to outside EMI (electromagnetic interference) that again raise concern on the use of RFID for a given business. The anti collision algorithm complexity for multiple data capture to avoid the interference between RFID labels is cause of delay in a complex business environment such as multiple order processing on a fast moving conveyer belt

The global implementation has impact because of regulations. Still there are incompatible national and regional regulations that make RFID implementation across geographically distributed business.

The environmental and safety clauses raise issues such as RF Human Exposure. The effect of RFID on Humans and the factors to control it are still not agreed.

The literature review and survey shows there are no such applications that resemble with the proposed architecture or solution. The closet application found during literature review is “Store Check-Out” and the closet solution is fast check out. The fast check out is for shortages detected in real time, enabling fast stock replenishment. It is different concept compared to RTSS concept [6]. The fast check out is not for customers or front users. Thus the proposed RTSS project is unique in itself and lead to research and knowledge gain that can be used in future for the implied use.

It is highly unlikely that the RFID technology will ultimately replace bar code. An RF tag will never be as cost-effective as a bar code label. RFID will be implemented in its established niches where bar code or other optical technologies aren’t effective.

It is observed that any RFID application architecture has 3 main layers [3]:

i. The application layer, that is the data and message transfers that are required for the industrial, commercial or other activity,
ii. The communication layer, that is how the RFID tags and the readers communicate and understand each other, and
iii. The transport layer that is the physical interface, frequency and data rate modulation.

In real life situation any RFID based enterprise solution implementation should include analysis and solution on following points. The effect of RFID data size and data storage for acceptable processing time and infrastructure costs. The solution should address multiple products scanning. It should adhere to universal standards and consumer privacy. It should have easy of operations and maintenance.

RFID Systems may be grouped into four categories namely ‘Electronic Article Surveillance’, ‘Portable Data Capture systems’, ‘Networked systems’ and ‘Positioning systems’ [8].

The EAS (Electronic Article Surveillance) systems are typically a one bit system used to sense the presence / absence of an item. The large use for this technology is in retail stores where each item is tagged and large antenna interrogators are placed at each exit of the store to detect unauthorized removal of the item (it is mainly used to control theft).

The Portable Data Capture systems are characterized by the use of portable data terminals with integral RFID interrogators and are used in applications where a high degree of variability in sourcing required data from tagged items may be exhibited. The hand-held interrogators/portable data terminals capture data which is then either transmitted directly to a host information management system via a radio frequency data communication (RFDC) link or held for delivery by line-linkage to the host on a batch processing basis.

The Networked systems applications can generally be characterized by fixed position interrogators deployed within a given site and connected directly to a networked information management system. The transponders are positioned on moving or moveable items, or people, depending upon application. RTSS can be categorized under networked system.

The Positioning systems use transponders to facilitate automated location and navigation support for guided vehicles. Interrogators are positioned on the vehicles and linked to an on-board computer and RFDC link to the host information management system. The transponders are embedded in the floor of the operating environment and programmed with appropriate identification and location data. The interrogator antenna is usually located beneath the vehicle to allow closer proximity to the embedded transponders.

In terms of operation one can generally say that there are three different types of technologies being implemented. They are ‘Magnetic field based RFID technologies’, ‘EAS based technologies’ and ‘Electric field based RFID technologies’. The commercial viable

technology for 'RFID integration with E-commerce and Security System for an unattended store / premises' has to be based on Electric field RFID. Other options are either commercially not viable or technological not feasible. For example EAS does not provide enough data in the message for proposed application. The Magnetic RFID is expensive compared to Electric field RFID thus cannot be used for retail applications[8].

The research for RTSS assumes that RTSS will integrate with an existing E-commerce transaction based application. It is worth considering having a right integration technology for E-commerce with RTSS. The integration technology is assumed based on the advantages and use of technology and its trend in E-commerce applications. The Linux / Windows with Apache, MySQL, PHP, Perl, and Python collectively comprise more than two-thirds of the servers, databases, and scripting languages on the web today. In part, it's the open source tools. They're freely available, easily configured, and very robust. They are in a constant state of development and improvement, adding features suggested by the user community at large. They can be easily deployed, fully configured, and maintained with a minimal amount of effort. All these technological elements assure that configuring and administering an E-commerce server with Apache, MySQL and PHP is simple and most used combination. Thus RTSS integration with E-commerce application involves Apache Web Server with applications in XHTML and JavaScript. The Application Server scripting language is PHP and the concept can be extended for any other open standard technologies such as Servlet based IBM Web Sphere Application Server, Sun One, and Tomcat etc. Further the E-commerce application has a Database Server. It can be MySQL, Oracle, DB2, MSQL, etc. Here RTSS proof of concept and its integration is considered in MySQL and MSQL. The use two technologies help in identification of any issues while integrating it with RFID [9].

The technology research shows that a RFID message based application can be design using object oriented principles. Java is selected because it is independent of hardware and operating system. The Java is an open source and open standard technology. The major concepts that can be used in RTSS are Java Native Interface (JNI), Remote Method Invocation (RMI), Java Multithreading, Java Networking, Java Security etc [10].

A RFID system has an interrogator, which transmits a signal at a given frequency to all RFID tags within its range. These RFID tags return a signal. When the tags are activated" by the interrogator, a dialogue is established according to a predefined communication protocol for exchanging data.

## IV. SYSTEM DESIGN

In a virtual (internet) shopping a buyer selects items, proceeds for payments and order confirmation with few clicks on an internet browser. In the Real Time Security System (RTSS) based business solution a buyer physically in a store pick up all the items to be purchased and put it in a shopping basket. Then the buyer proceeds to check out exit. At this moment RTSS RFID receiver system will register all the items with a customer. The RTSS will calculate the total payment and ask buyer to authorize the payment by entering his password on a key pad. This will complete the payment and in general complete an E-commerce order transaction. The above solution allows a physical store application to be integrated with RTSS to make it a complete 100% unattended store.

The propose idea and solution will provide the innovation (knowledge based logic) and technology (RFID transmitter and receiver) integration to help retail merchant organizations run more efficiently while improving safety and security of assets and sell of products. The RTSS has other use as well where one can implement RTSS applications especially within corporate and public buildings like healthcare facilities, stadium, schools, theme parks, unattended stores etc [3].

The business model is described in work flow and data flow diagrams for the complete business process. The business diagram is built based on four major functional entities. The functional entities are Customers, Store Manager, Unattended Store and Payment / Delivery Manager. The Store Manager identifies a customer through personal ID card (based on RFID tag) issued to the customer. The Customer visits the Unattended Store. In the Unattended Store, the Customer adds items (RFID tagged) in a shopping basket (cart). The Customer proceeds for automated check out (Unattended Teller). The automated teller process the order for the items in the cart. The Customer accepts the order and confirms payment online. The Payment Manager approves the payment and approves delivery. The Store Manager confirms the order processing and delivery of the items. The Customer leaves the unattended store. Figure 1 illustrates a general business processes.

The dynamics of RTSS business concept and the above work flow can be explained using an Activity diagram. Activity diagrams show the procedural flow of control between objects while processing an activity. The Activity diagram is used to model higher-level business process at the business unit level. The Activity diagram of figure 2 describes the dynamics of the required RTSS system. It illustrates flow of control from activity (operation) to activity (operation).

The RTSS use case illustrates a unit of functionality provided by the system (Figure 3). The main purpose of the use-case diagram is to visualize the functional requirements of the RTSS system, including the relationship of "actors" (human beings who will interact with the system) to essential processes, as well as the relationships among different use cases. The Use Cases captures need of RTSS processes. The use cases describe pattern of behavior that RTSS system exhibits. It provides outside view of the system.

The following actors make the RTSS system.

**Table 1: Use Case Description**

| Use Cases | Goal & Description |
|---|---|
| Identify Customer | Process that identifies a customer in an Unattended store |
| Process Shopping Cart | Automatically process shopping cart of a customer |
| Process Order and Payment | Process order and payment to confirm delivery |

The Use Case is sequence of related events for a process. In design the use case realization is done using Sequence Diagram and Collaboration Diagram. The Sequence diagram in figure 4 shows a high level flow for the RTSS use case, it shows the calls (events) between the different objects in their sequence. A sequence diagram has two dimensions: The vertical dimension shows the sequence of messages / calls in the time order that they occur; the horizontal dimension shows the object instances to which the messages are sent.

## V. SYSTEM ARCHITECTURE

A view of complete end to end solution called candidate architecture is shown in block diagram in figure 5 below. Here a RFID tag (transponder) in the vicinity of RFID reader (interrogator) acts as user interface. The RFID reader communicates with the tag and receives a raw data message from the tag. The raw message is communicated to RTSS server. The RTSS server process the raw data message (binary and Hexadecimal) in ISO 15693 format. The message is translated into a human understandable string format. The RTSS interface uses this message to initiate a transaction on B2B / E-commerce application.

The above end to end architecture can be divided into 4 layers as shown in Figure 6. The first layer is physical layer that comprise of RFID devices such as RFID tags and RFID Antennae. A RFID antenna transmit radio signal with command in it. The RFID tag responds to that signal and sends back message with requested information. The RFID antenna forwards the tag message to RFID reader (a piece of device software that understands messages from antenna) in next layer called as RTSS middle layer. The RTSS reader communicates with RTSS client. One RTSS client is dedicated to one RFID reader. The RTSS client identifies the RFID reader its location and its purpose. The complete raw message is transferred to RTSS server. The RTSS server understands the message, decode it in right format and validate security requirements. The approved decoded message is passed to next layer called as RTSS enterprise layer. The RTSS enterprise layer consist of RTSS interface for external E-commerce application that forms the next layer called as Business enterprise layer. Here in the research it is assumed that we have business enterprise layer available to us.

The table 2: Technology Features below describes technology features, its class and scope for a solution and its implementation. It is planned to include only those features that are essential to demonstrate hypothesis feasibility.

**Table 2: Technology Features**

| Technology Feature | Feature Type | Prototype Scope |
|---|---|---|
| Content Communication | Data in RFID tags (100 bytes per tag) | Yes |
| Security required | Privacy<br>Non repudiation<br>Integrity<br>Authentication<br>Regulations | No |
| Data Searches | High for a RFID data read | Yes |
| Unique Items processing | High in actual business scenario | Yes |
| Transaction Volume | High in actual business scenario | No |
| E-commerce Integration | High | Yes |

In a RTSS application, the Client is an RFID transceiver (with decoder) with antenna or coil that emits radio signals to activate the tag and read or/and write data to it. The Server is the main server with functionality, being able to process RFID data from many Clients. The RTSS interface is an intelligent logic function that initiates a business transaction for an E-commerce Application.

For this research a prototype of a RTSS system is be developed. This prototype focuses on the receiving and processing of RFID data, which are communicated between the RTSS components.

The RTSS concept can be packaged in three software modules or packages. The overall RTSS system will consists of 3 packages as described in Table 3.

The database requirements are designed as data structures in MySQL. The MySQL database covers the RTSS data needs for its module and functions. The E-commerce application data is accessed using E-commerce interface (plug-in). The table ID_REFERENCE has data for devices such as transponders and interrogators. Events related to transponders and interrogators are recorded in EVENTS table. Every order has link to device in ID_REFERENCE and EVENTS. Each ORDER contains lines in ORDER_LINE and is associated to a customer.

Each ORDER_LINE has listed products from PRODUCTS. The above relationship is illustrated in the ERD of Figure 7.

**Table 3: Package Description**

| Package (Module) | Description |
|---|---|
| RTSS Interface | An application, which is responsible for providing all interface methods (functions) necessary for automation to E-commerce applications. |
| RTSS Client | An application, which is responsible for providing all methods necessary for the RFID client. This includes the receiver, and its location and sending RFID data to the server. |
| RTSS Server | An application, which is responsible for providing all methods necessary for the RTSS server. This includes processing of received RFID tag data from Client and generating interface request for an E-commerce application. |

The physical architectures utilize two-tier system of client and server. The systems use one server. The system has 10 RTSS clients. The system is intranet based. If required the server can be connected to the Internet using HDSL for E-commerce integration. The RFID Interrogator and Transponder communicate through Radio Waves. The RFID Interrogator communicates with RTSS client through application program to program communication (APPC). The RTSS client and server are connected over TCP/IP connectivity. The RTSS Server talks to RTSS interface through APPC. The RTSS interface in turn communicates with Enterprise E-commerce Application over TCP/IP.

Figure 8 illustrates the RTSS network categorized into architecture layers. The component modeling (Figure 9) visualizes physical nature of the system. It illustrates organization and dependencies with software components like code files, run-time objects and executables. The source code shows dependencies of files (language specific). The run-time component modeling shows mapping of a class to run time libraries such as java objects, dynamic library and other components. The executable modeling describes interfaces and calling dependencies.

The deployment modeling (Figure 10) illustrates processors and devices that are represented as nodes. The nodes are connected by association indicating communication path between them. The software processes are shown as text attached to each node

## VI. PROTOTYPE

A prototype was implemented for the proposed system. Figure 11 shows the E-commerce internet shopping page that is activated when the customer enter security validation on internet shopping page. Figure 12 provides a view of data interchange between RTSS and E-commerce application through a cookie.

Figure 13 shows the E-commerce shopping that displays an order confirmation screen. Figure 14 shows when the customer accepts order and enters order billing details and figure 15 shows when customer enters payment details.

## VII. CONCLUSIONS

In general a RFID system is used as identity tag and in particular to replace bar coding. A RFID system is suitable for identifying a physical object. A RFID system do not need direct scan unlike barcode scanning. The RFID devices (interrogator and transponder) use radio waves to communicate. In general the RFID has two main features that make the RFID preferred choice for automation of a work flow to gain benefits. The first feature of RFID is to identify an object without direct scan. The second feature of RFID is to scan multiple objects simultaneously. A RFID tag cost more than Barcode printing. But overall it saves a lot for a business work flow if used for work flow automation. There are various solutions available and implemented for supply chain management. These solutions in general use RFID at Pallet / Case level. The present research concentrates on automation of retail process that involves customers. Here one can save on total man power required to manage a physical retail store and store tills if RFID at item level is implemented in a retail store. One can reduce number of persons at Security / Payment Till required at store counter and exit. More over RFID can automate and reduce human errors at payment counters. It makes the process efficient. In general a customer can save approximately few seconds per item. For example a customer can save 10 minutes in every visit to purchase 100 items.

In the proposed solution a commercial transaction takes place the moment a customer (buyer) reaches the store exit gate. The proposed solution if implemented will cut down operational cost for retail stores and a business can pass the benefit to customers. It will ease customer shopping by extending shopping hours in retail physical stores.

The proposed prototype is an application that integrates RFID based message application with a transaction based E-commerce application. The research

deals with the design and implementation of a prototype RFID system called as RTSS. Three applications are developed: the RTSS Client, the RTSS Server and the RTSS Interface. The applications are implemented in open standards and are built on top of open source libraries. The prototype system is tested for its proposed normal use.

The results confirm that the method works. It meet its stated objectives and requirements "to design, develop & evaluate a message based RFID prototype using RFID antenna, a transceiver and a transponder to integrate it with transactional based E-commerce application and / or security system. The model implements a system that automates tracking of physical objects and initiates a business transaction based on location of RFID tagged objects".

The conclusions concerning the worth of the system are accurate from the system evaluator's perspective. The successful prototype is sufficient evidence for claims about the system's worth.

## REFERENCES

[1] Burstein, F. Gregor, S. (1999) The Systems Development or Engineering Approach to Research in Information Systems: An Action Research Perspective. Proc. 10th Australasian Conference on Information Systems, pp.122-134.

[2] Laudon, Kenneth C., Traver, Carol G. (2003) E-commerce: Business, Technology, Society (2nd Edition). Addison Wesley.

[3] I Shepard, Steven. (2004) RFID. McGraw-Hill.

[4] EPC Class 1 Specification. [Internet]. Nov 2002. Available from: <http://www.rfidjournal.com/whitepapers/download/17> [Accessed 05 Mar 2005]

[5] Guardbook. [Internet]. Available from: <http://www.guardbook.com/> [Accessed 19 Dec 2004]

[6] RFID Solution Zone Tour. [Internet]. Available from: <http://www.rfid.access-events.com/solution_zone.asp> [Accessed 16 Dec 2004]

[7] AIM Global. [Internet]. Available from: <http://www.aimglobal.org/technologies/rfid/resources/papers/rfid_basics_primer.asp> [Accessed 17 Dec 2004]

[8] Dowla, Farid. (2004) Handbook of RF & Wireless Technologies. Oxford: Elsevier(Newnes)

[9] Oliver, William R. (2004) Module MSC-IN-040429-03 Programming the Internet. University Of Liverpool.

[10] Watson, Kimberly.(2004) Module MSC-JV-031016-04 Object Oriented Programming and Design Using Java. University Of Liverpool.

## Figures

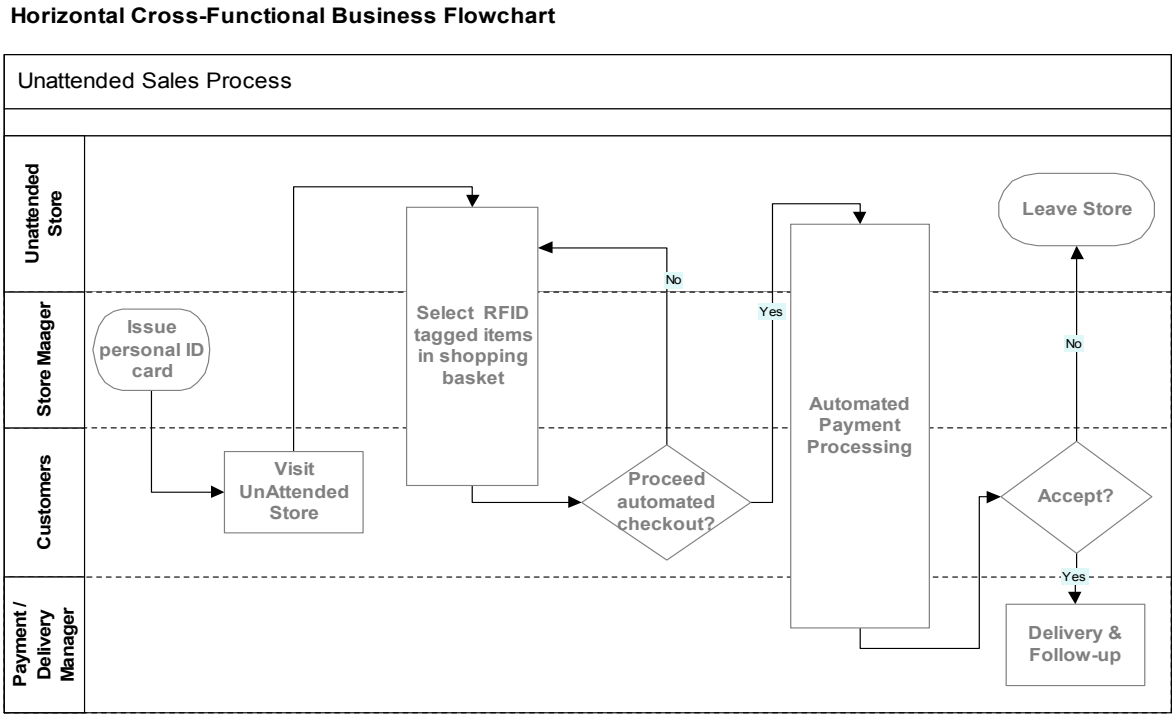


**Figure 1: The Work Flow Diagram**

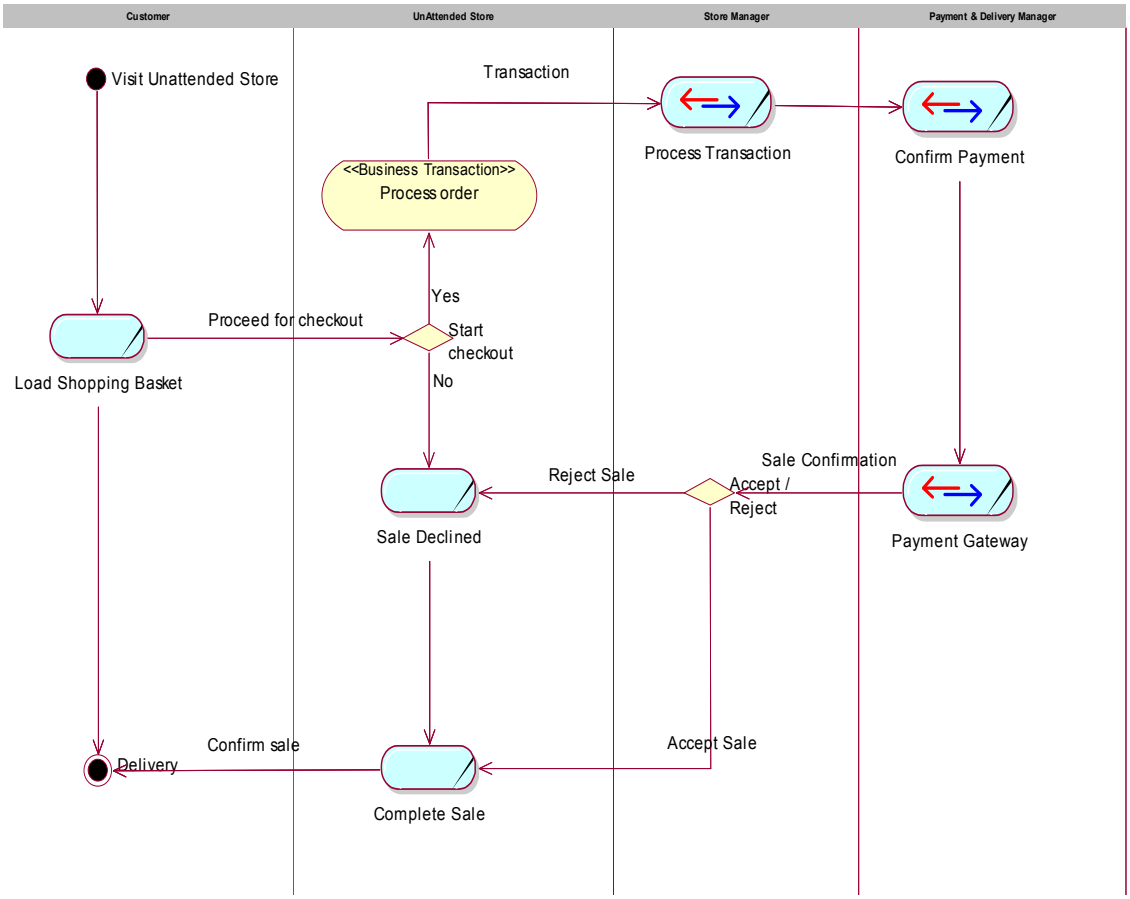


**Figure 2: RTSS Activity Diagram**

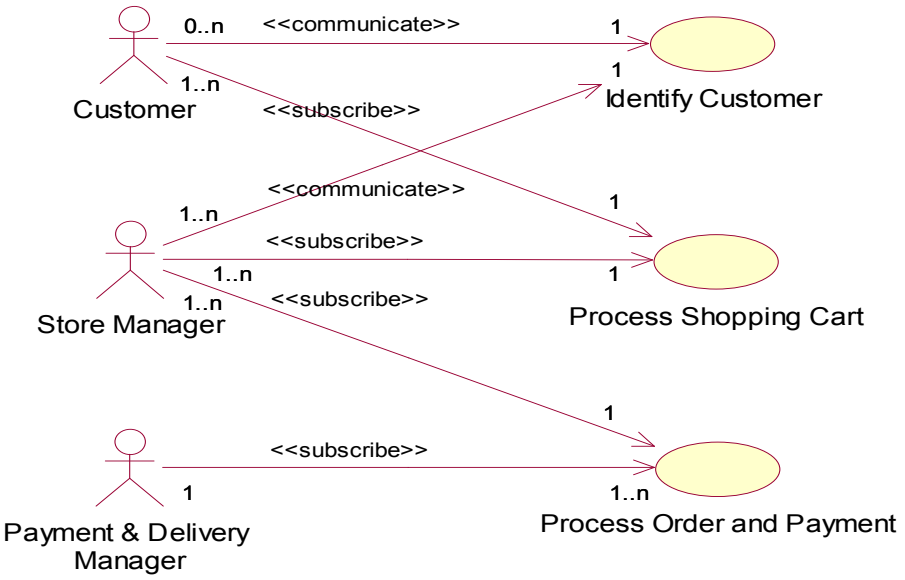


**Figure 3: RTSS Use Case Diagrams**

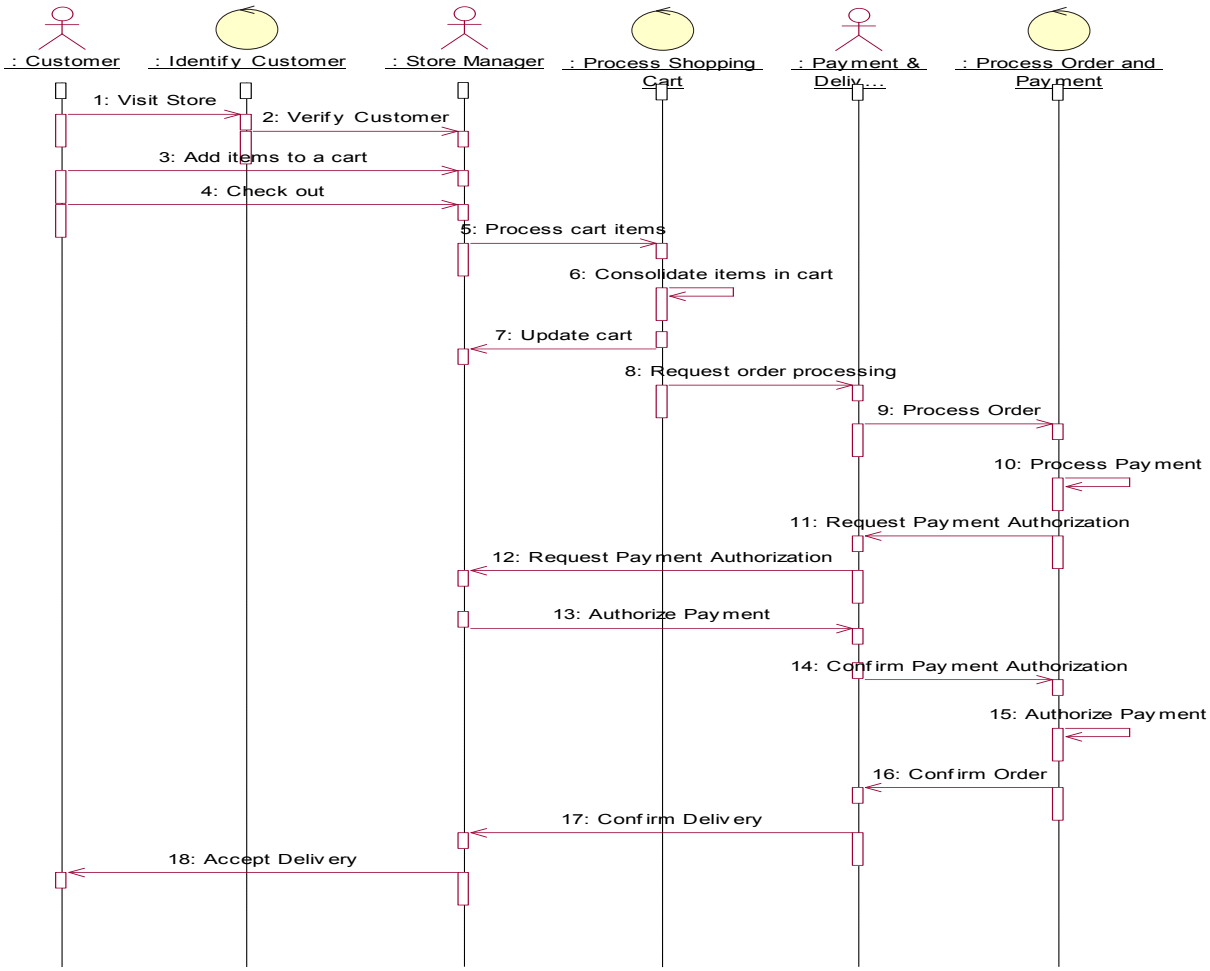


**Figure 4: RTSS Sequence Diagram**

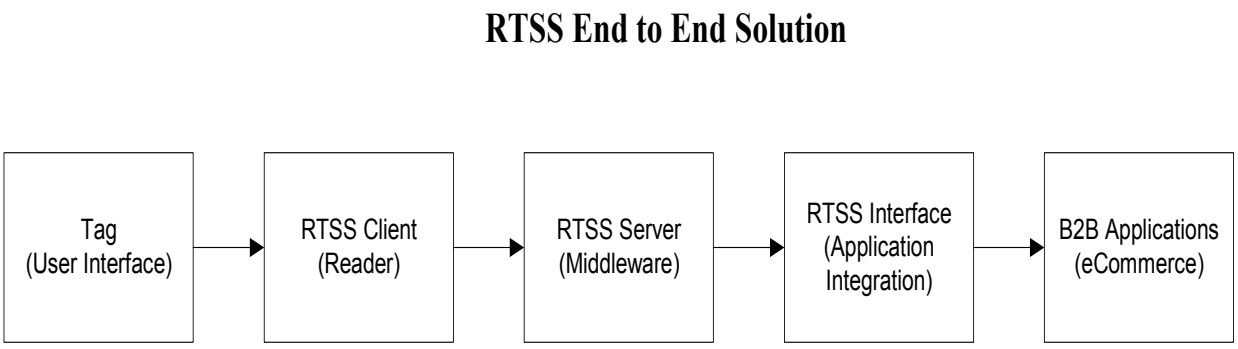


**Figure 5: RTSS End to End Solution**

**RTSS Architecture**

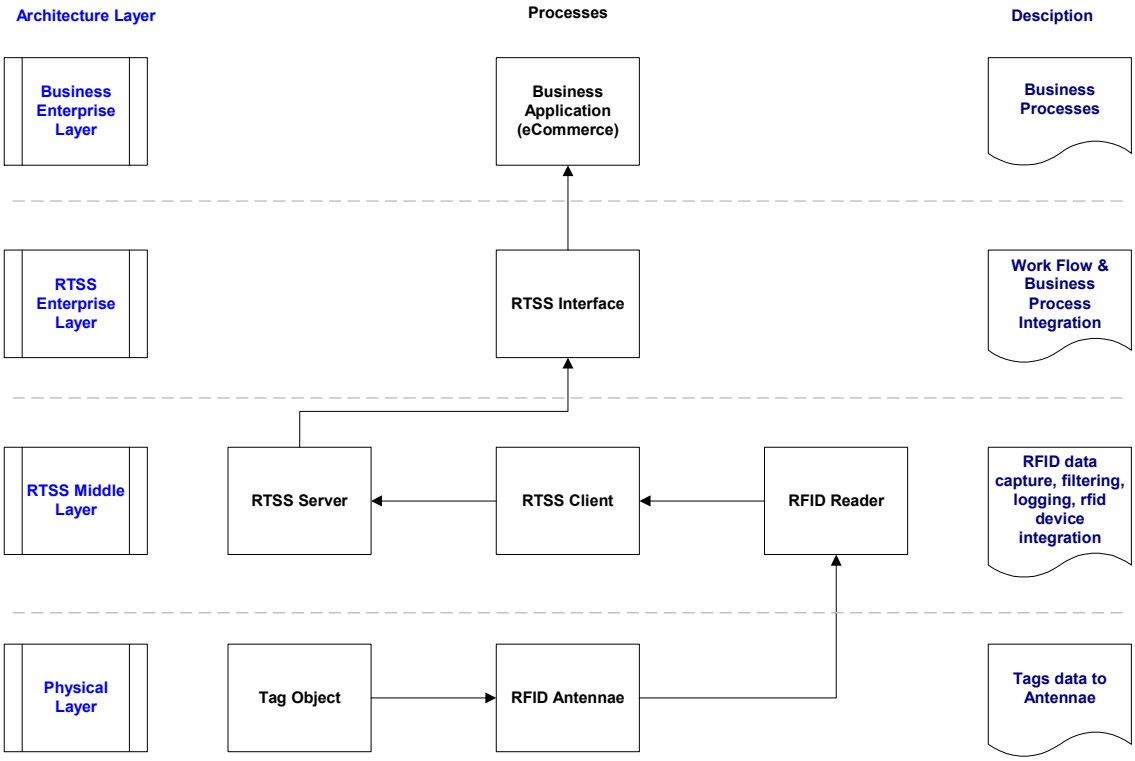


**Figure 6: RTSS Architecture**

**Entity Relationship Diagram**

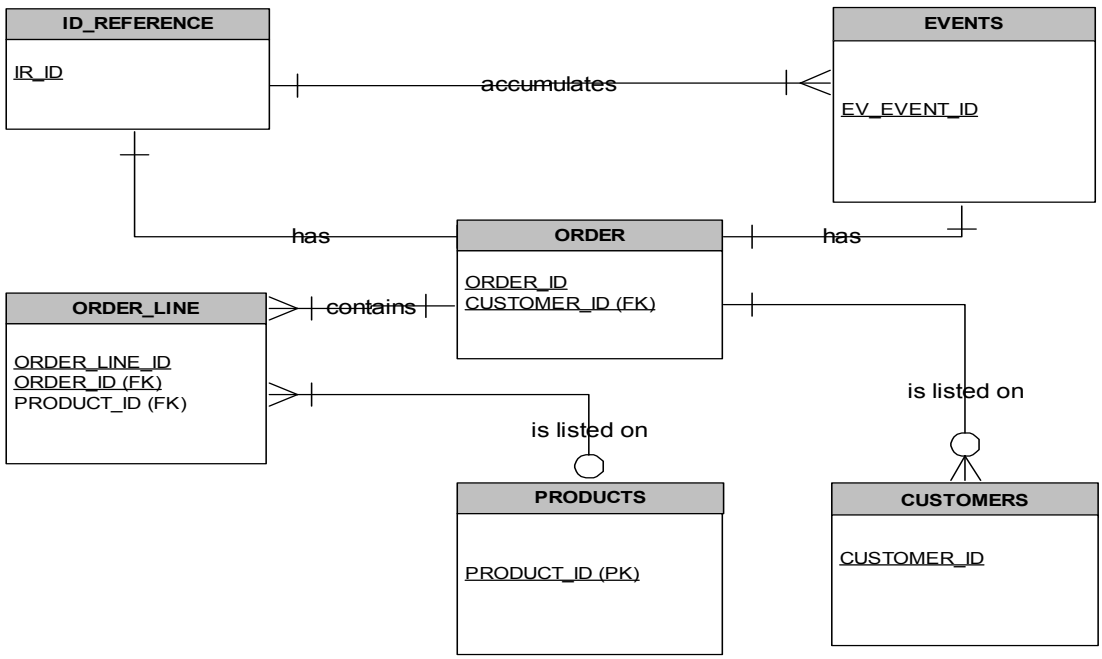


**Figure 7 :ERD**

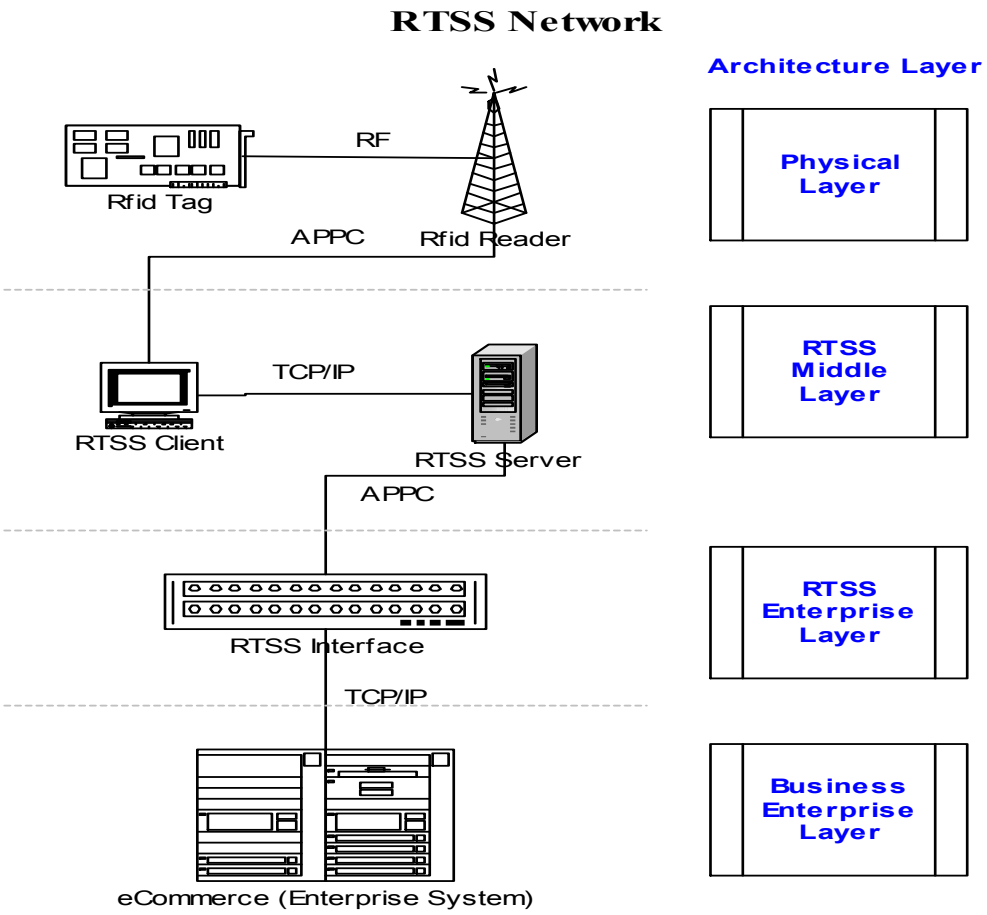


**Figure 8: RTSS Network Diagram**

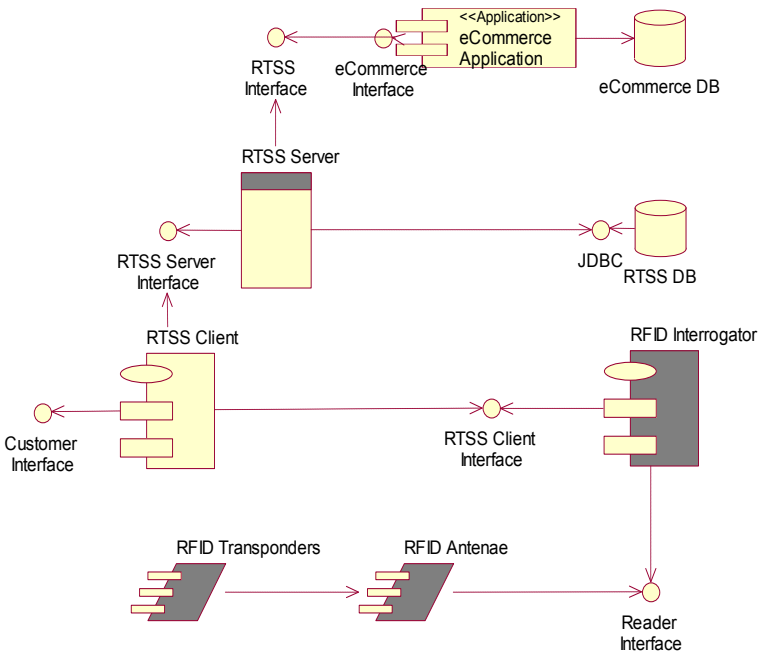


**Figure 9: Package Component Modeling**

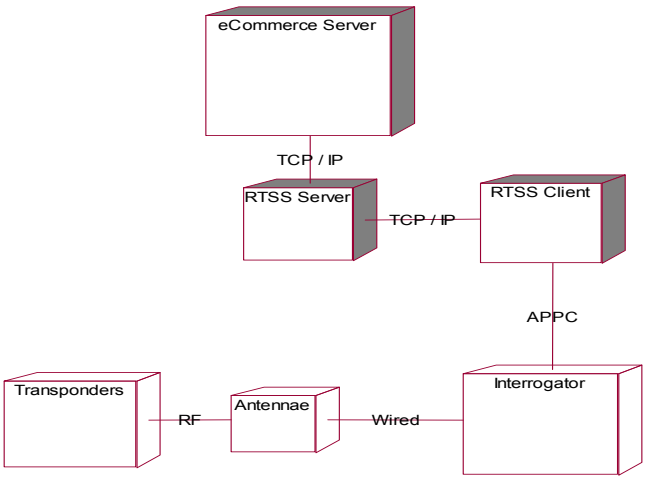


**Figure 10: Deployment (Node & Connection) Modeling**

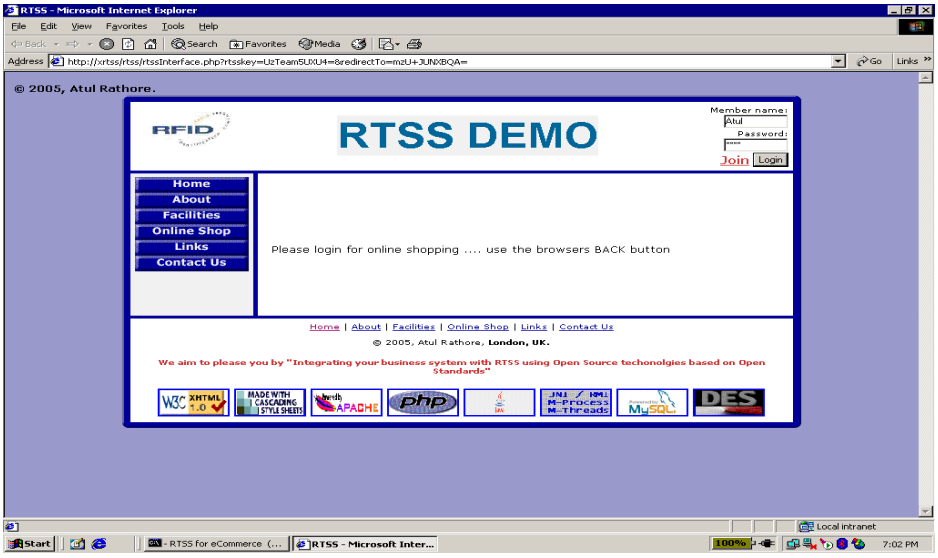


**Figure 11: Input for E-commerce internet shopping**

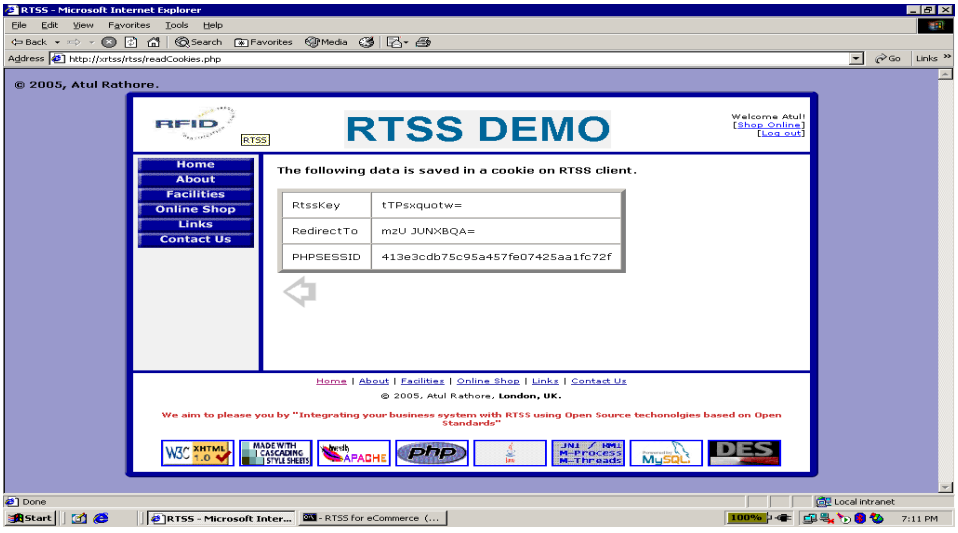


**Figure 12: RTSS and E-commerce communication though a cookie**

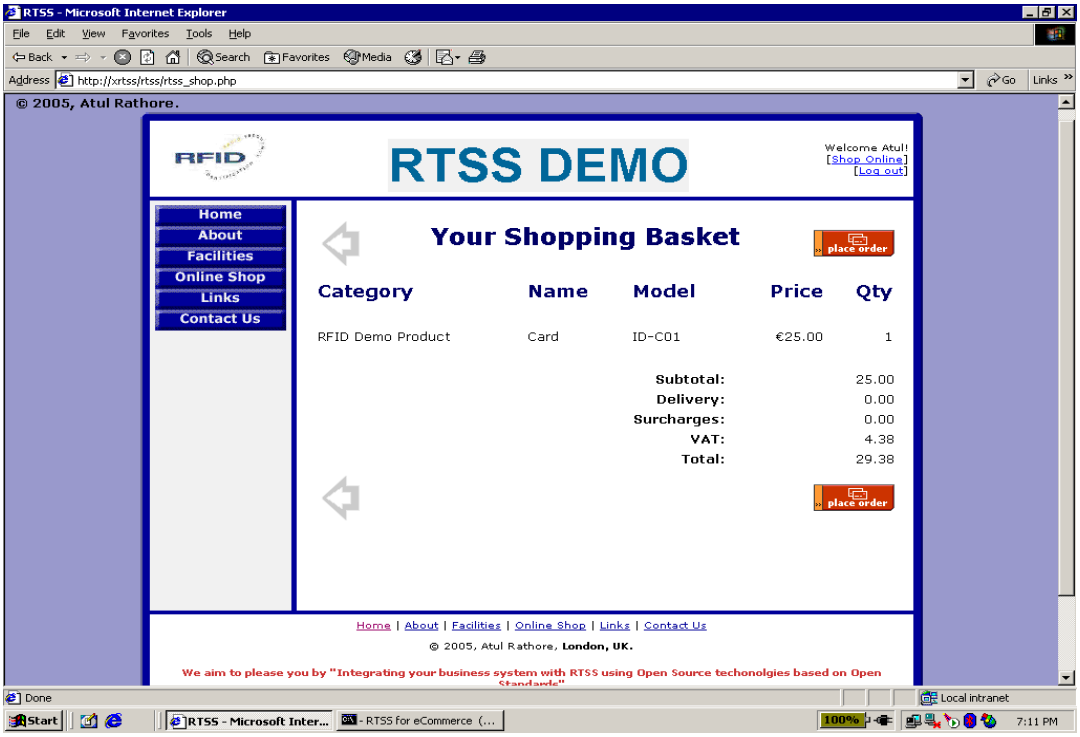


**Figure 13: E-commerce Shopping basket**

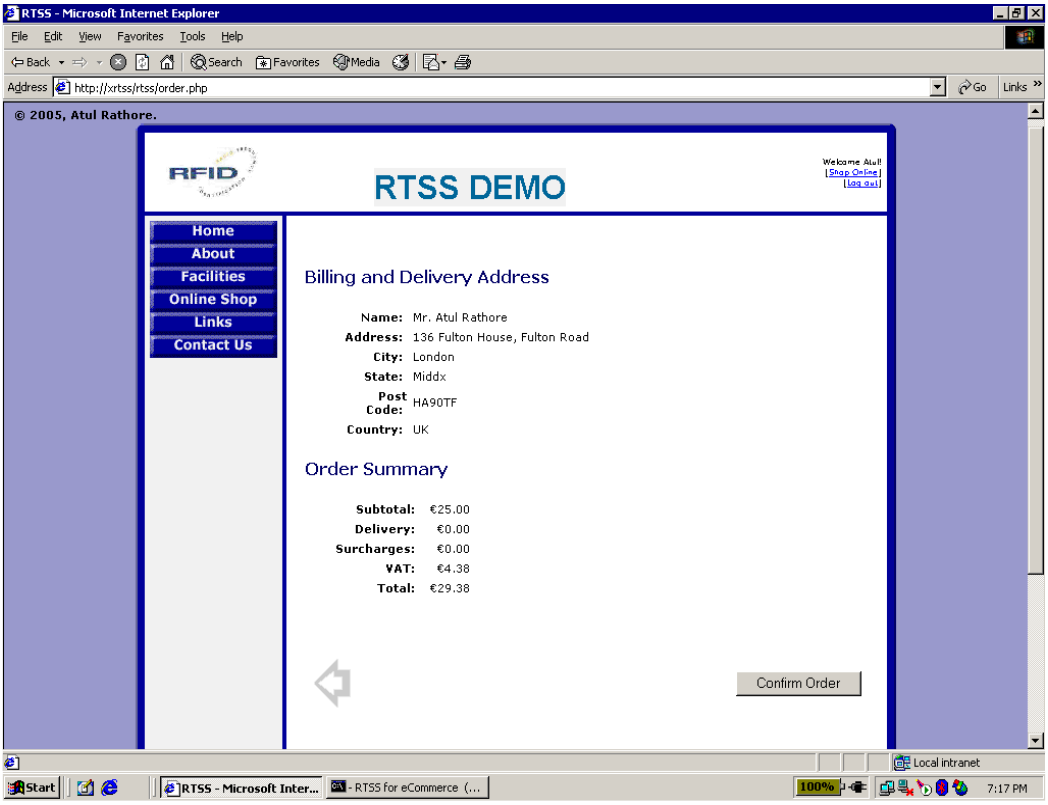


**Figure 14: Order billing**

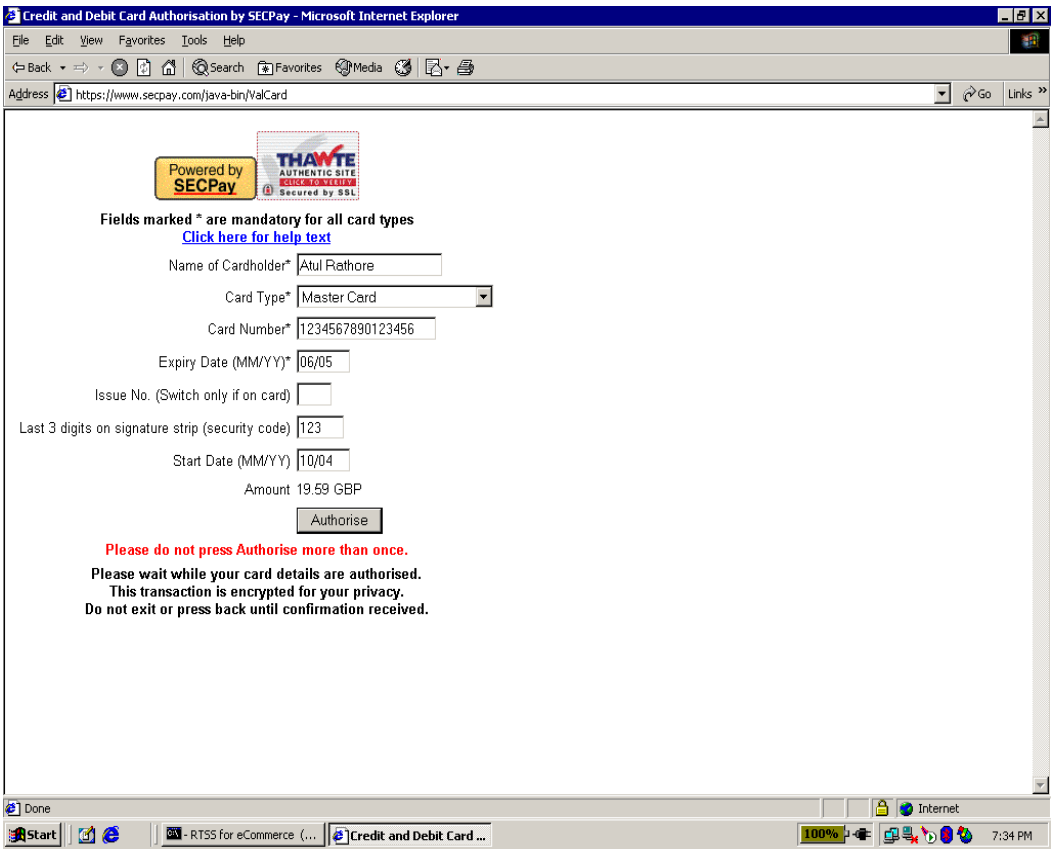


**Figure 15: Payment gateway**