Design Issues on E-marketplaces for Returns

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Abstract

In recent years, commercial returns, excess inventory of products, returns comprising of products at the end of their economic lifecycle and discarded used products or packaging gain increased attention for economic and environmental reasons. Markets for returns are highly fragmented. Thus, e-marketplaces are examined for their potentials to defragmentize such highly fragmented markets. However, e-marketplaces for returns need to address specific requirents related to a new set of operations involved (i.e collection of returns, assessment of their status and decision making for their reuse, remanufacturing or recycling) and the unique characteristics of end-of-use products (i.e. uncertainty factors regarding the time and place of origin, their condition and configuration and estimation of residual value). In this paper, we identify and analyze the design issues on returns e-marketplaces. Based on these, we present an architecture and a prototype for an e-marketplace for end-of-use PCs. In the proposed e-marketplace, users register their requests and offers regarding end-of-use PCs and their modules and they get notified when a match is found. Also, this e-marketplace offers trustworthy and low-cost web-enablde services to perform remote monitoring and benchmarking of registered end-of-use PCs and a decision support system for their optimal recovery options.

Keywords Reverse Logistics, E-marketplaces, E-marketplace Architecture, Remote Monitoring and Configuration Detection.

1. INTRODUCTION

In recent years, commercial returns, excess inventory of products, return flows comprising of products at the end of their economic lifecycle, discarded used products or packaging, have received increased attention due to several inter-related developments:

- **Legislative frameworks.** In the EU, legislation acts, also called "producer responsibility laws", require Original Equipment Manufacturers (OEMs) in certain industry sectors to develop a policy for the collection and reuse of their products at the end of their lifecycle.
- **Environmental impact.** Depletion of natural resources and environmental awareness make the reuse of recovered products and parts desirable. Furthermore, consumers' orientation towards "green brands" presents marketing opportunities for products made out of recovered parts or materials.
- **Competitive Advantage.** Efficient handling of returns leads to reduced costs, increased profits and improved customer service. Returns related costs for U.S. companies in 1997 were estimated to $35 billion (0.5% of the U. S. GDP) [9].

- **Asset Recovery.** Sectors that have experienced significant shorting for the lifecycle of their products, like consumer electronics or Information and Communication Technology (ICT) equipment, could regain value out of their used products by reusing products or parts.
- **Emerging Paradigm of Extended Products.** The shift from buying products to buying products coupled with sets of services (like preventive maintenance, service, upgrading etc) make necessary to reuse recovered products or parts.

In relation to returns management, e-commerce has been examined [4,7,10] for its potentials to defragmentize such highly fragmented markets, release the trapped value of returns and act as a consolidation channel for returns collection. Also, e-marketplaces can be used for the reintroduction of recovered products or parts back in the original or secondary markets. E-marketplaces for returns, however, need to address new requirements imposed by the new set of activities involved in returns management and the unique characteristics of return flows. Design issues for e-marketplaces specialized on returns have not been examined before.

In this paper, we examine the design issues related to e-marketplaces for returns, propose an architecture and demonstrate a prototype of an e-marketplace for returns. We show how e-marketplaces for returns can support aspects of the operations involved in returns management. More specifically in the context of an e-marketplace for end-of-use PCs, we have developed a decision support subsystem for recommending the optimal recovery options and a subsystem for the remote detection of the configuration and condition of returns.

Within this framework, the proposed architecture is very appealing, because it automates several, previously manual, operations and offers a trustworthy mechanism for the assessment of the configuration and condition of the returns. Even more importantly, it provides a cost-effective and cohesive platform that defragmentizes the returns market and releases trapped value. Furthermore, the proposed system maintains profiles for all potential buyers to give recommendations in alignment with their interests and preferences. Finally, the proposed architecture demonstrates the feasibility of e-marketplaces for returns and provides us with an understanding for further research and development. These are the main contributions of this paper, which is structured as follows: in section 2 we describe the main issues related to returns management and identify the new information requirements in e-marketplaces for returns. In section 3, we describe the architecture of an e-marketplace for returns, followed by the implementation of a prototype for end-of-use PCs. Open issues and conclusive remarks are summarized in section 4.

2. INFORMATION REQUIREMENTS FOR RETURNS E-MARKETPLACES

To understand the information requirements of e-marketplaces for returns, we examine the major operations involved in returns management and identify which aspects of them could be supported by IT processes. Also, we analyze the type of information generated and exchanged between operations in reverse logistics networks to develop a data flow diagram for the processes in the e-marketplace.

Typically, returns management operations include collection of returns, inspection of their status and separation for reuse, re-manufacturing or recycling followed by re-distribution of the recovered products or parts in the original or secondary markets. In Figure 1, we show how these activities, denoted as rectangulars, form a network, where the connecting arrows depict flows of returns. Such networks, also known as reverse logistics networks, can be integral part of supply chains forming Closed Loop Supply Chains [3,5]. The main objective of reverse logistics networks is to extend the useful lifecycle of returns.

To illustrate this point, we use an example from the computer industry. At first, products are purchased based on their technical specifications, depicted as the arrow from the supply chain to the buyer, in Figure 1. For example, a company buys a web server for its e-commerce project. After the server is delivered and installed, its packaging could be retrieved for recycling, denoted in Figure 1 as the star arrow from the buyer to the supplier. Eventually, however, products reach the end-of-use stage. In our example, the industry standards have evolved or the company's transactions have increased and that particular server can no longer support them. With the aim to prolong the useful lifecycle of products or support alternative uses for the products themselves or their parts, reverse logistics networks accepts end-of-use products or other returns. In Figure 1, return flows are depicted by the arrow leading to collection operation, which is

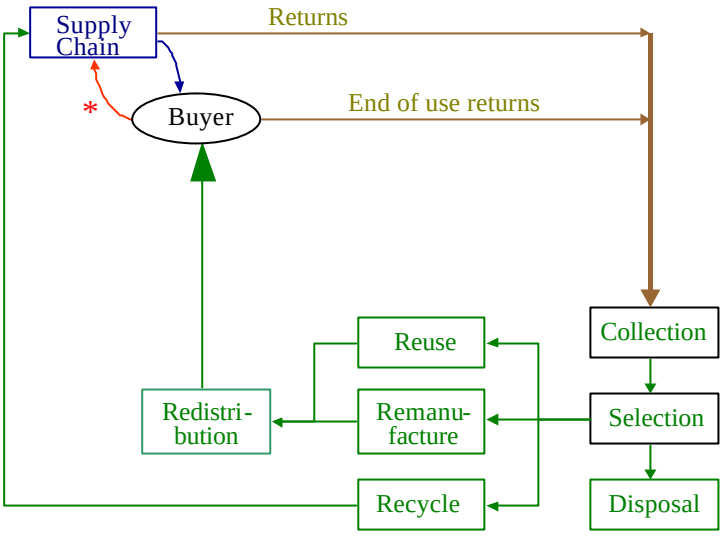


Figure 1 Operations for Returns Management

the first operation in a reverse logistics network. In our example, we can follow the reverse logistics principles, when the computer is dismantled in modules that:

i) can be directly reused as spares: CD ROMs, hard disks, the keyboard etc.

ii) can be remanufactured into new products: old chips get used in electronic toys, and

iii) he rest is recycled.

Anyway, with new or old functionality the product (or parts of it) enters the market again. Certainly, at some future point in time, the product or its parts would reach again the end-of-use return flow and they would enter again in a reverse logistics network.

The operations of reverse logistics networks entail both physical and information processing for the incoming returns. During the collection operation, for example, returns are gathered and sorted based on their functionality and status. At the same time there is some information created, like identification of the returns and recording of the place and time of origin. In Table 1.1, we list the operations in reverse logistics networks with the information they accept as input or create to pass to subsequent operations in the network. Operations in a reverse logistics network could have been planned and controlled more efficiently, if adequate information on the upcoming returns was available, beforehand. For example, routing for the collection of returns could be optimized if the place of origin and the timing of returns could be known in advance. Furthermore, in the absence of any information on the condition of upcoming returns, all recovery can be returns was possible, then policies could be devised to motivate the owners to follow an optimal recovery plan. In view of these, e-marketplaces are examined in relation to returns management as facilitators both the collection of returns and their distribution back into the market, as shown in Figure 2. The added value of an e−marketplace in this dual role would be:

- To act as a consolidation channel for the collection of returns from a highly fragmented market.
- To receive information from the users about the incoming returns.
- To motivate users to follow optimal recovery policies for their returns.
- To facilitate better planning and control of returns management.
- To facilitate reintroduction of recovered products or parts back into the original or secondary markets.

Table 1 Information flows for reverse logistics operations

REVERSE LOGISTICS OPERATIONS	INFORMATION INPUT	INFORMATION CREATED
Collection	Historical Data Location of the Collection Center	Identification of the return(s) Quantity Place of origin Timestamp
Selection	Identification of the return(s) Quantity	Configuration (BOM) Quality assessment Remaining value estimation Reuse, remanufacture or recycle?
Reuse Remanufacture	Identification of the return Quantity Configuration of the return (BOM) Quality assessment Remaining value estimation	Bill of Recovered Product/Parts Quality Grade(s) Price Quotation(s)
Recycling	Identification of the return Quantity Configuration of the return (BOM) Remaining value estimation	Bill of Recovered Parts/Materials Quality Grade(s) Price Quotation(s)
Redistribution	Bill of Recovered Product/Parts/Materials Quality Grade(s) Price Quotation	Invoice Info
Disposal	None	None

- To collect historical data that would enable cost efficient multi-echelons of the reverse logistics networks i.e. to collect and disassemble products with known reusable components locally and forward only the reusable components to a centralized facility.

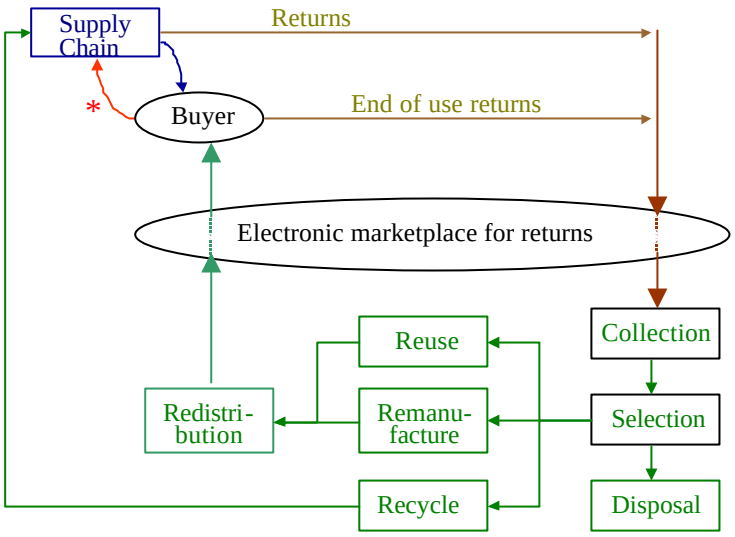


Figure 2 E-marketplaces for returns management

In this paper, we examine how e-marketplaces for returns could facilitate operations in reverse logistics networks by enabling consolidation of incoming returns, data collection on returns configuration and condition and decision support systems for their recovery.

3. THE ARCHITECTURE AND A PROTOTYPE OF AN E_MARKETPLACE FOR RETURNS

The overall architecture of the proposed e-marketplace adopts the Model-View-Controller design pattern [2]. In our implementation, the View object is a standard Web Browser, the Model object is a RDBMS, while the application Controller object has been implemented in Java (Java Servlets and Java Server Pages). The electronic marketplace is decomposed into the following subsystems, as shown in Figure 3:

- *Repository*: holds all application data. The persistent storage of the repository is guaranteed by the use of a relational database system. All textual data are stored in Unicode format.
- *Application Server*: accepts/process all HTTP requests.
- *Security*: controls system access in conjunction with the Java Cookie technology.
- *Mailer*: sends a notification to the appropriate recipients of the system, every time a new request or offer has been successfully submitted.
- *Presenter*: presents the appropriate Java Server Page (JSP) or HTML according to the user status (registered or not registered) and requests.

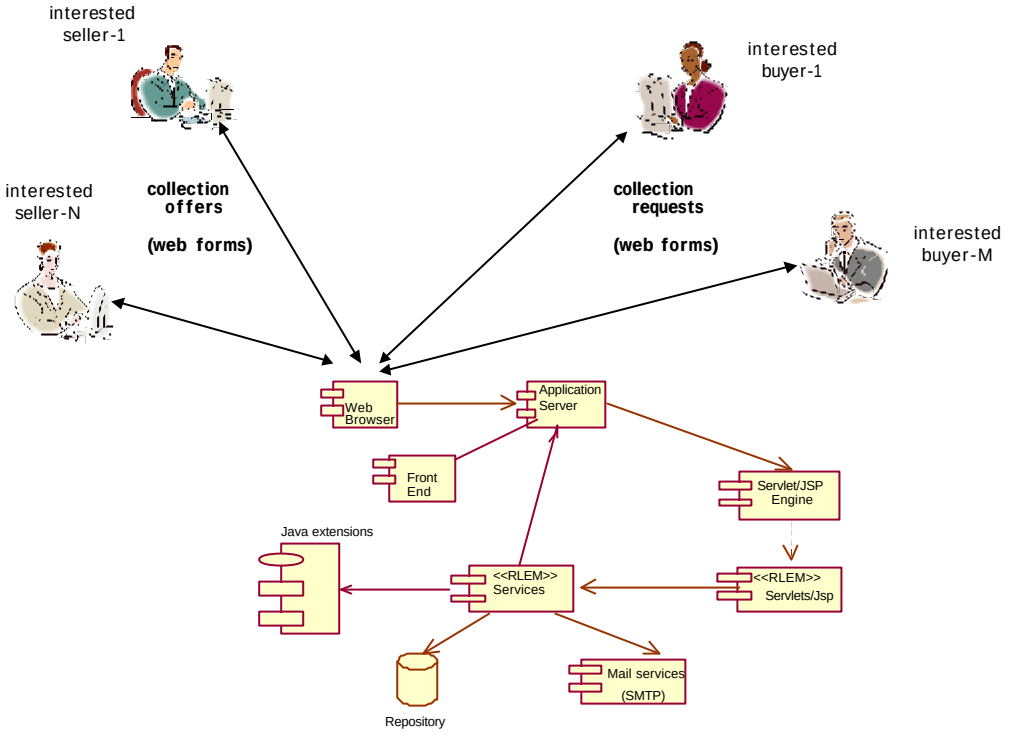


Figure 3 The Architecture of an E-marketplace for returns

The main points of interest in the workflow of the proposed architecture, which is presented in Figure 4, are the following:

- User Registration
- Handling offers and requests for returns
- Detection of returns configuration and condition
- Decision support for reuse, remanufacture or recycling
- Matching requests and offers, and
- Notification of potetntial trading partners by e-mail.

Each of these points is addressed in a prototype, called RL4PC [6], of an e-marketplace dedicated to returns of PCs and their modules. We selected to develop the prototype for the domain of used PCs for three reasons. First, ITC equipment is subject to the EU Directive on Waste of Electrical and Electronic Equipment that requires OEMs to develop policies for their collection and reuse. Second, end-of-use PCs are ranked by the Environmental Protection Agency as the fastest growing category of solid waste. Finally, PC returns represent a source for significant asset recovery estimated at $15 billion [1].

In our prototype, users register with their e-mail address and password. These are checked for validation and authentication to avoid different users having duplicate registration information. Also, for each registered user, a cookie is created with the user's registration information and it is stored in the user's browser for later use. Optionally, a user may register information on his/her location, which could be used at a later stage to facilitate routing of the collection operation. The subsystem that is responsible for handling users' offers provides a wide range of computer components from which a user can select, accordingly. Dynamically after each selection, the system gives an estimated value for the

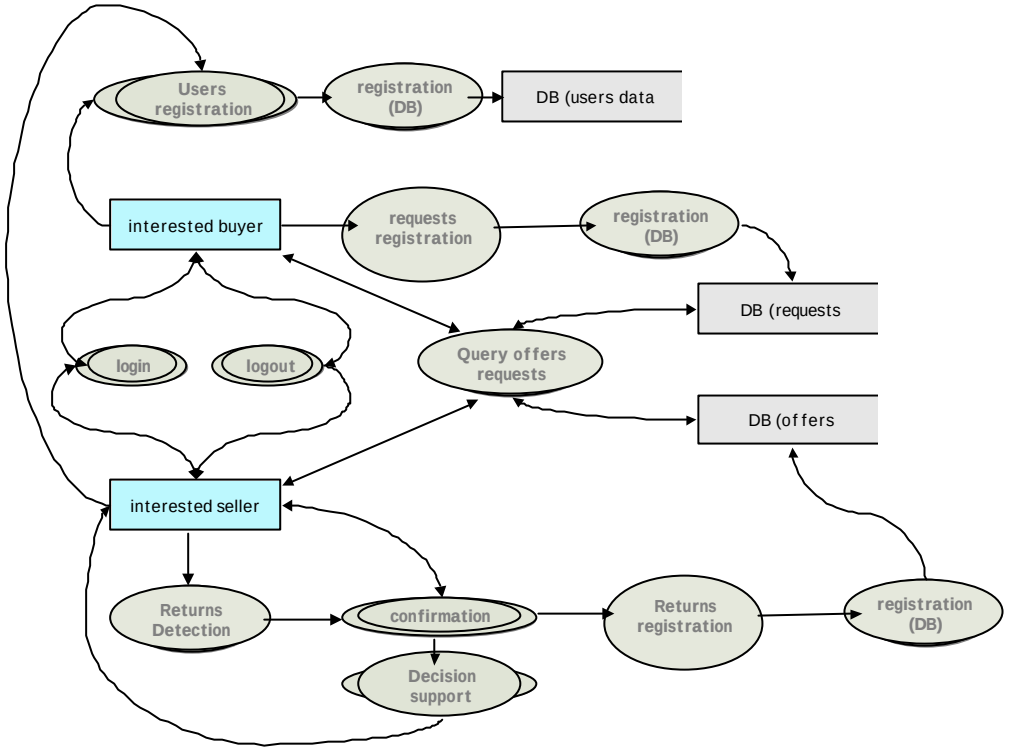
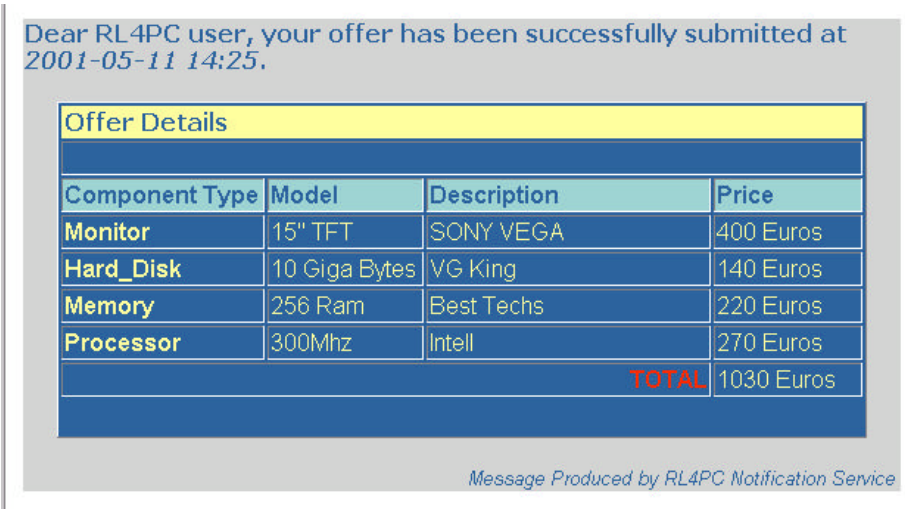


Figure 4 Workflow of an e-marketplace for returns

selected component. Upon users' confirmation the offer is saved in the repository. The user interface for a submitted offer is shown in Figure 5. Similarly, the subsystem that handling requests enables the users to select from a wide range of computer components and submit their requests.

Users, who wish to register the return of a PC, may request configuration detection and benchmarking of their PC. They need to use the PC they wish to return to connect to the Internet and initiate the subsystem for hardware detection in the e-marketplace. This module employees a trial version of "PC Examiner", as shown in Figure 6. Upon users' confirmation, these data are saved in the repository as an offer.

The decision support subsystem is accessible to registered users only and it is based on the offers that have been successfully processed, so far. It has twoo basic components, namely, an inference mechanism and a library of strategies. It provides general guidelines for reuse, remanufacturing or recycling. Only in the case of re-use, it provides recommendations for upgrading modules of the PC in request. As shown in Figure 6, in that particular case, the PC should get additional disks. Periodically, requests and offers are checked for potential matches upon a series of attributes. When a match is found, the e-mail subsystem is responsible for sending notification e-mails to interesting parties.



Dear RL4PC user, your offer has been successfully submitted at *2001-05-11 14:25*.

Offer Details

Component Type	Model	Description	Price
Monitor	15" TFT	SONY VEGA	400 Euros
Hard_Disk	10 Giga Bytes	VG King	140 Euros
Memory	256 Ram	Best Techs	220 Euros
Processor	300Mhz	Intell	270 Euros
		TOTAL	1030 Euros

Message Produced by RL4PC Notification Service

Figure 5 An offer submitted by a user

5. CONCLUSION AND FUTURE WORK

In this paper, we have studied the design issues for returns e-marketplaces and proposed an architecture and a prototype for end-of-use PCs. We have shown how the approach lowers the uncertainty associated with returns and, as a result, contributes to more efficient and effective returns management systems. Our web-based system is fully implemented in Java. In the future, we plan to examine how this approach can be extended to address the installed base of ICT equipment and their recovery options within a large organization. In that respect, additional requirements regarding users access rights and privacy should also be considered. Further to the development of optimal recovery policies for ICT supply chains, we also plan to examine how this approach can be extended for other products and particularly for those with embedded intelligent control systems. This can open new directions for research and applications in the field of agents for reverse logistics.

ACKNOWLEDGEMENTS

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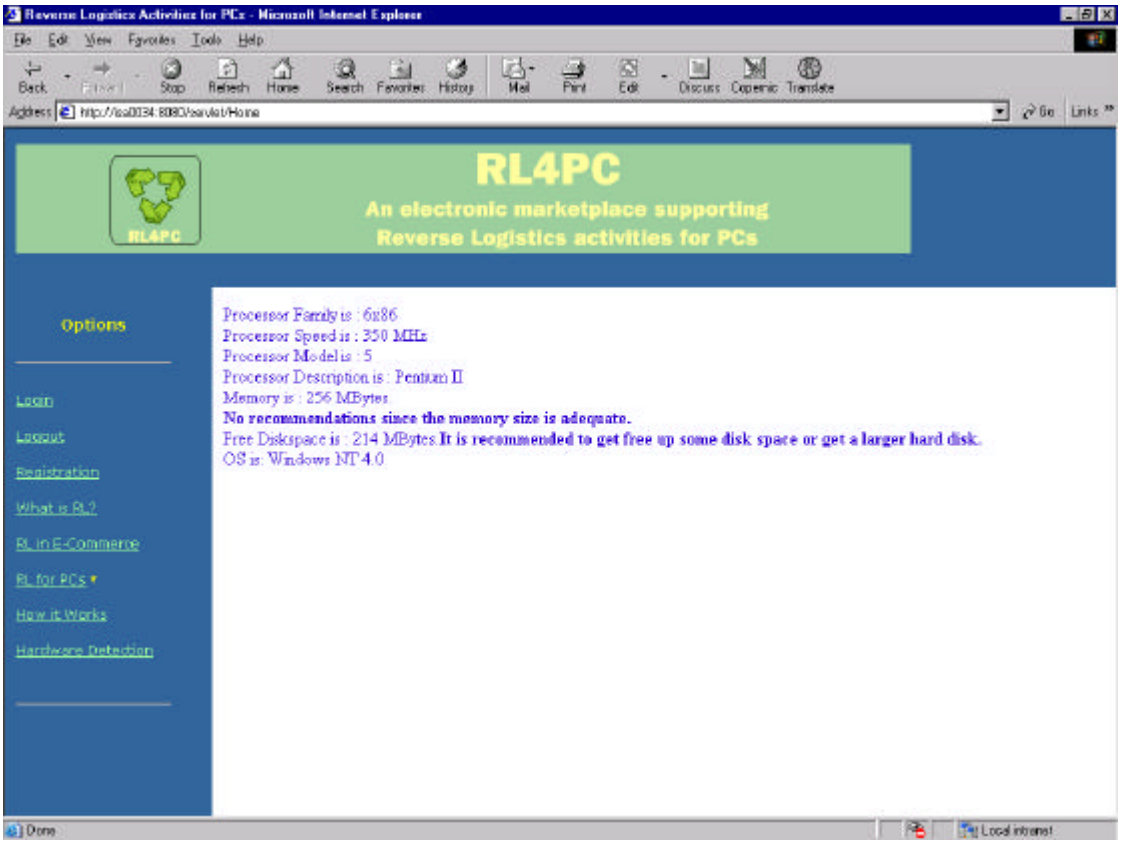

Figure 6 Results of a PC configuration

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