The Real Potential of an RFID_B2B Integrated Application

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***Abstract*—RFID (Radio-Frequency Identification) technology has been considered one of today's "hottest" technologies due to its specialized capacity to track and trace objects in real time. This paper examines the impacts and potential benefits generated by RFID technology integration in B2B applications. A proof of concept is also presented to demonstrate the feasibility of a RFID_B2B application in one specific supply chain. Through a proposed scenario, we demonstrate how RFID technology can introduce new opportunities for enriching the enterprise systems with new ways to operate efficiently and better address the demands of business customers. Also, it can be demonstrated that RFID enables more integrated and more collaborative business-to-business (B2B) ecommerce solutions. We can conclude that the paper helps to improve the understanding of the real potential of integrating RFID technologies in B2B applications.**

***Index Terms* — RFID, B2B, tag, supply chain**

Motto: „The companies that will succeed in business will be the ones that will manage to come up with the most efficient global networks." (P. Kotler)

I. INTRODUCTION

RFID (Radio Frequency IDentification) technology is classified as a wireless Automatic Identification and Data Capture (AIDC) technology. RFID allows to identify, locate, track and monitor each and every item (product, box, pallet, etc.) and to obtain continuous real-time information on these items from the factory, through shipping and warehousing, to the retail location [1, 2]. Incorrect or outdated data used in invoices, bills of lading (a document from the carrier indicating the description of the goods being shipped) or purchase orders can result in product delivery errors and lost sales estimated at more than $50 billion annually [3]. But RFID technology could prevent these costly data inaccuracies.

Business-To-Business (B2B) is the exchange of products, services, or information between businesses rather than between businesses and consumers [4, 5].

For many companies, providing real-time product availability to customers at minimal operation costs is an important factor that determines the success of their businesses. One study that came out of IBM reveals that 70% of a typical distribution center's cost is labor [6]. Tagging inventory upstream with RFID tags and automating this process via an integrated RFID-B2B solution achieve high levels of accuracy with better labor efficiencies and better velocity.

Through a detailed investigation of a business-to-business process, we demonstrate how RFID technology can introduce new opportunities for enriching the enterprise systems with new ways to operate efficiently and better address the demands of business customers. Also, it can be demonstrated that RFID enables more integrated and more collaborative business-to-business (B2B) ecommerce solutions [6]-[8].

II. SOFTWARE ARCHITECTURE

Our research team has developed one RFID_B2B software system which provide both B2B and RFID advantages and which can be considered as a viable solution for potential problems raised by globalization process. The software system deals with business relations between corporations, big companies and groups of companies, in order to optimize the flow of materials between them and the supply chain management inside every company.

Our software system uses RFID technology by using passive 13.56 MHz tags for parts and finite products identification. In this way, using unique ID's we can control and trace every part of one finite product. By extending this to the entire supply chain management (final producer, suppliers, suppliers of suppliers, etc) the final consumer can follow the entire production chain of one finite product. In order to achieve this, all information regarding traceability will be memorized on each tag attached to a part of the final product.

The following case study scenarios illustrate the many benefits retailers can achieve through the deployment of RFID_B2B solutions – including a significant reduction in stocking levels, increased customer satisfaction and sales.

III. CASE STUDY

Let's consider a production company who will be referred to as Company PROD. This company has three storehouses and one of them is located somewhere else. Each storehouse has two entry gates (a main one and a secondary one) and two exit gates (also a main and a secondary exit), which are supervised by some various embedded devices with RFID readers attached, which will be called "gates".

The system architecture is presented in the Figure 1:

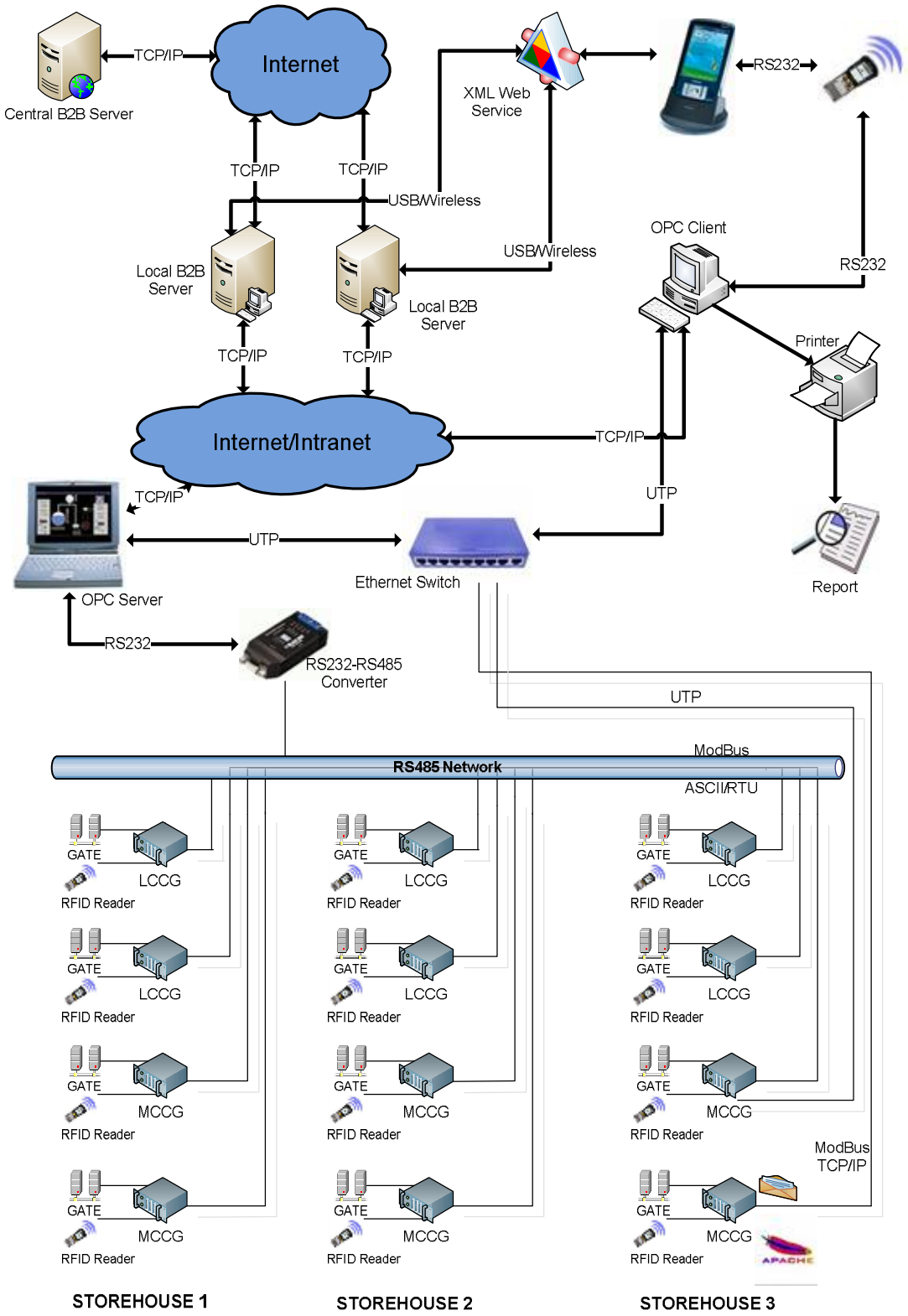

Figure 1. The system's general architecture.

Relating to this architecture we can note that the integrated software system includes:

- one IBM-PC compatible computer which runs an OPC server with two main components: communication and data acquisition;
- one IBM-PC compatible computer which runs an OPC dedicated client, this computer can be the same as the first one;
- one network of different gates devices, every one of them having attached a RFID reader, which provides local data processing;
- PDA devices with RFID readers attached too;
- one IBM-PC compatible computer which runs Local B2B server [9];
- one IBM-PC compatible computer which runs Central B2B server [9].

In this case study, we will consider four different complexity gates for each storehouse that are connected to a

RS485 network that will end on a PC with an RS485-RS232 connector [10]-[13]. The system can also use an Ethernet type connection by using MODBUS TCP/IP communication protocol.

Every storehouse has a PC connected to the Internet that runs OPC data server (OPC DAServer) [14]. The OPC client application can be installed on every computer connected to the company network and can be used to watch data flow, to modify the information from RFID tags and so on. At this level (company level), the application will be installed on a central system, which implements next operations: collects data from all deposits, store data in a database, compute reports about inputs/outputs, stocks, etc.

Basic information submitted by control gates (read from RFID tags) are imported by the OPC Data Server and saved into central company database server using the Internet connection available. The software system we are presenting allow also the use of PDA devices which can be used to read/write RFID tags associated with different products/parts.

Another feature of the software system we are presenting is that inside a company we can install a WEB server that will make some information available to the general public (future partners) or to associated companies.

Let's consider the following case study [15]. Let's suppose that a company named A receives an order from a partner company named B for a Desktop PC with next components inside: mainboard All-In-One Asus K8U-X, Socket 754, processor AMD Athlon 64 3200+, HDD Western Digital Caviar SE 200GB, tower: Mid-Tower. Every component of the PC has an RFID tag attached that allows unique identification of each product and contains specific product data. The components are registered at the exit of the initial warehouse and read at the entry of the destination warehouse. All the information are used in order to build the stocks database or for later analysis like finding transport times. One user of the system can determine when and where one RFID tag was write/read and can trace all significant aspects related to that specific product. Information related to stocks is then sent to the main server of the company A in order to be accessed by the partner companies registered into the system, if this is permitted through configurations.

Our system provides a high degree of generality allowing to the users to define their own templates, which describe the data format to be memorized on tags [16]. On these templates is permitted also to be defined some scripts [17] that will be used to trigger some local processing at the level of gates when a tag is read.

IV. System Functionality

As we already presented, at the level of the producing company, each product (including the final one) will have attached an RFID tag. Each tag will pass through the RFID writing/reading area of at least three RFID readers, connects as follows:

1. PC reader where the tag for the final product will be initialized. At this level will be readed all information from each component tag and all significant information will be writed to main tag.
2. at the gate level, where the main tag will be readed, the script will be executed and the content of the tag will be updated, if necessary.
3. at the PDA level, in order to verify data related to each component or to the final product. At this level data can be processed in order to read/write component's tags or the final product tag.

According with this kind of organization, we create necessary templates for each component and final product at the PC level (Figure 2). Also, we can create scripts that are compiled to byte-code and writed to tags that will be executed when the tag is readed at any level (PC/PDA/gate) (Figure 3). For instance, for final product tag we can define a script that will be executed at the level of the distribution company. If we assume that the product is not accepted (PROD_ACCEPTED = 0) then the product should never be intercepted at any gates but the entry/exit ones. The following script will generate a "forbidden gate" event when that product is detected anywhere inside the company (gates, PDA, etc.).

```
#DEFINE   PERMITTED_GATE  0x00 BYTE

//permitted only on entry/exit gate

#DEFINE   EVENT_FORBIDDEN_GATE  0x55 BYTE

//event for a forbidden gate (usually at gate
level)

#DEFINE ACCEPTED  0x0A BYTE

//field 10 on tag (PROD_ACCEPTED)

#DEFINE GATE_COUNT_FIELD 0x00 BYTE

//we will define a field that will

// memorize the number of gates

// that the product passed

#DEFINE GATE_MAX_COUNT  0x0F  BYTE

//10 gates maximum

#DEFINE SEND_MAX_COUNT_REACHED 0x00 BYTE

//we are defining the event

INC(GATE_COUNT_FIELD)

//the number of passé gates is incremented

IF(GATE_COUNT_FIELD == GATE_MAX_COUNT)
SEND_MAX_COUNT_REACHED

//if the maximum number of gates reached, then
//send an event

IF(ACCEPTED == 1) STOP

//if accepted then we are not triggering any event

IF(GATE!= PERMITTED_GATE)  EVENT_FORBIDDEN_GATE

//if wrong gate, we are generating an event

STOP
```

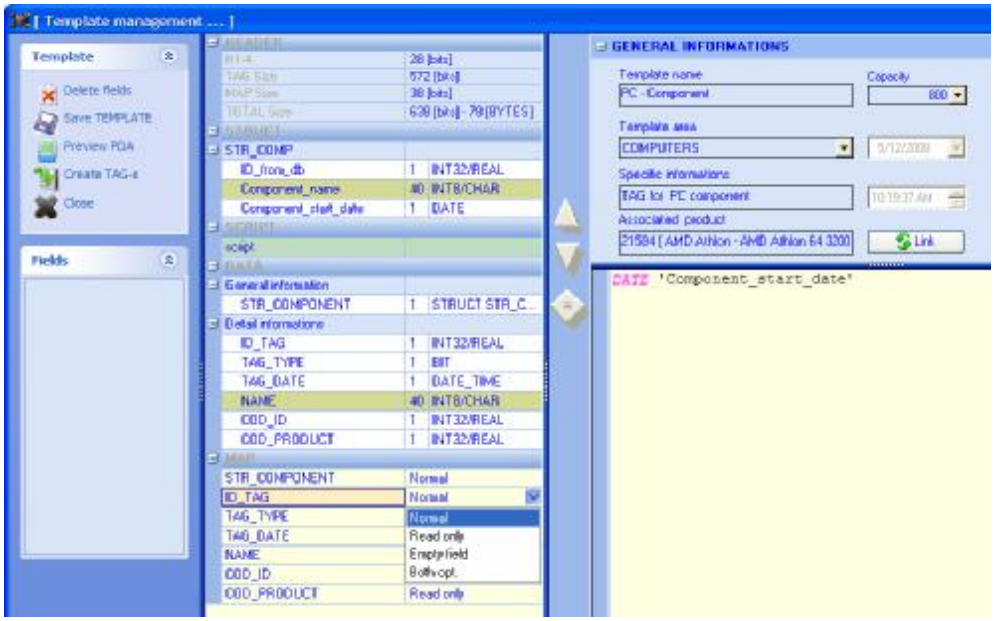

Figure 2. The PC-Component template window.

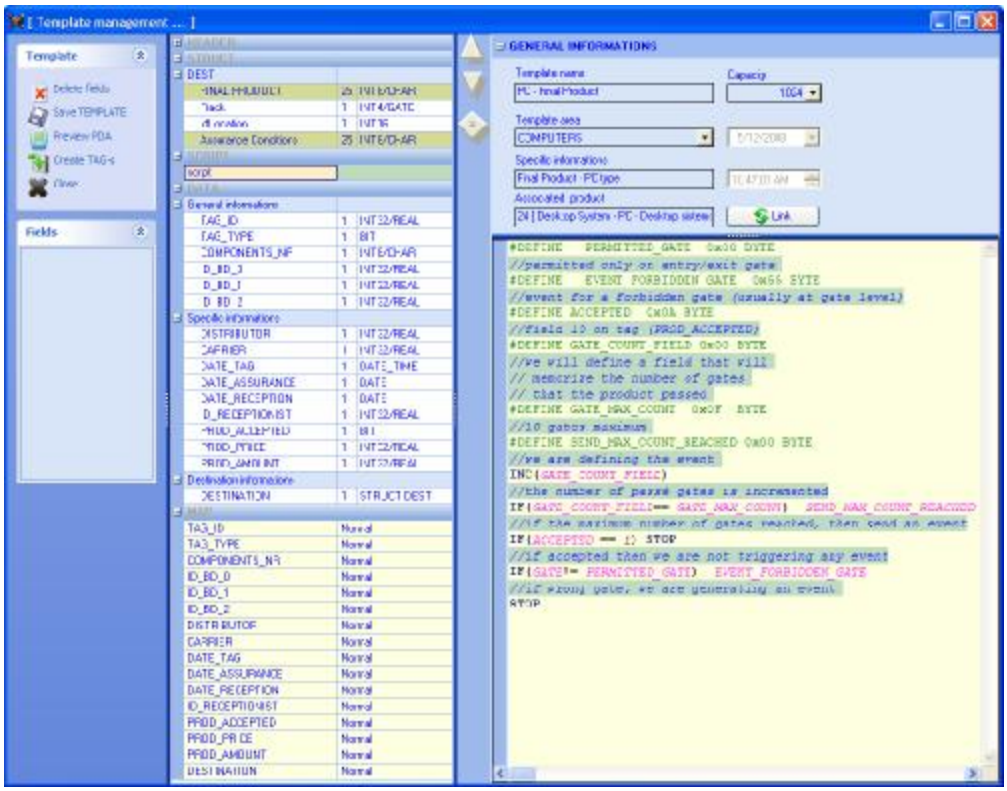

Figure 3. The script– template PC – final product window.

We have to mention that when a template is created we have to establish visual groups for a better organization of the considered fields, so that, at the PDA level the visualization of data to be correct and logical. With this purpose in mind, we can activate the pre-visualization field when we are creating a new template (Figure 4) and thus we are implementing the correct and desired configuration. According with this, we can watch the way data will be displayed at PDA level (Figure 5).

The templates we created are used in order to write some product tags with specific information. This information is recorded both on database and tags (Figure 6).

The stock database and the database from the web-server will be updated with information related to the products. The user can create a succession of personalized reports using the report editor embedded into our system (Figure 7) that allows specific SQL statements to be generated and which can be saved to text files in order to be used later. After displaying the requested data, we can choose to export data into an Excel file.

The templates and tags we created can be exported from database into an XML file or can be imported from an XML file into the database. In addition the XML file can be mailed, at request, to a business partner.

Figure 4. PC Component. PDA Preview, first and second visual zone.

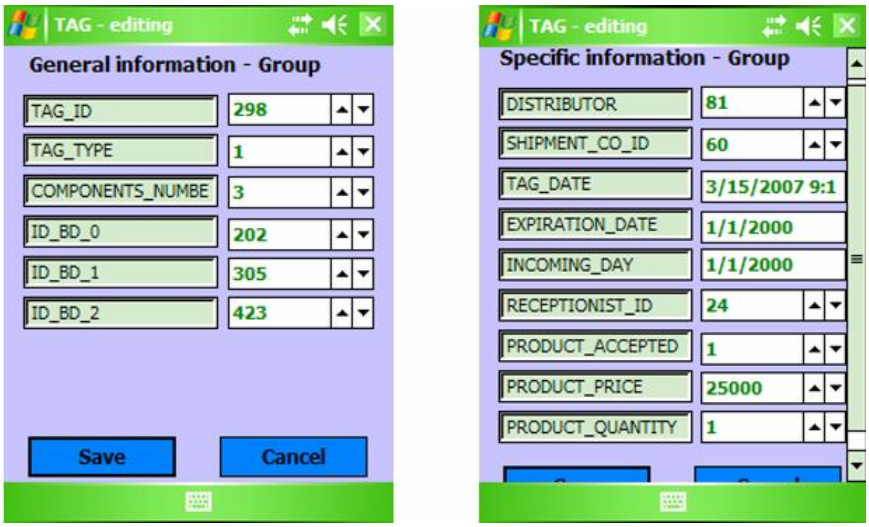

Figure 5. PC Component. First and second visual zone on PDA.

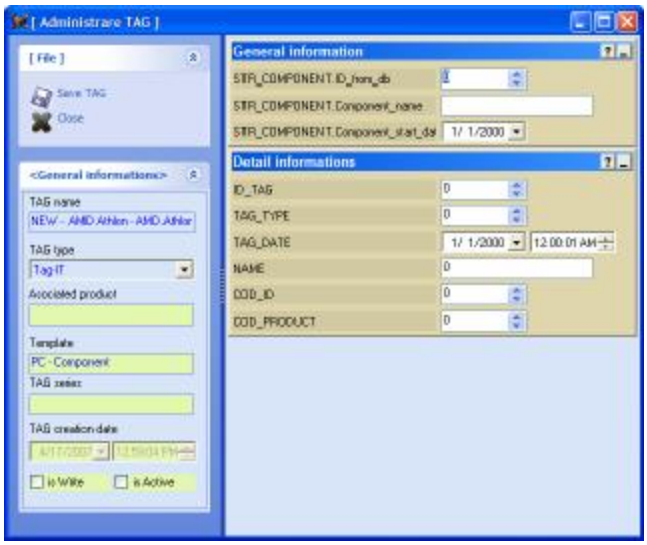

Figure 6. The window for the tag associated to the motherboard.

At the gates level, when a tag is detected in the proximity of a RFID reader, the entire content of the tag will be readed. After that, the authenticity of the tag will be verified and by this we mean if any information about the actual tag exists in our database. If not, an alarm/event will be generated. If the tag is correctly authenticated then the gate will make a series of data processing as requested by the central PC or by executing the local script from the tag. So, the gate will read the entire content of the tag and, if necessary, will write new data or just update some fields from it. All data readed from the tag at gate level will be sent to the central PC using the communication component that is running there and therefore writed to the central database. All events generated by the gates are recorded in their internal memory and also by the central PC into the database. In addition, some advanced gates can be accessed using a WEB interface using a user and a password.

After WEB authentication users are logged on their main (Figure 8).

Using the menu from the upper part of the WEB page, the authenticated user can consult various reports regarding traceability of tags: a HTLM table with tags readed by hours.

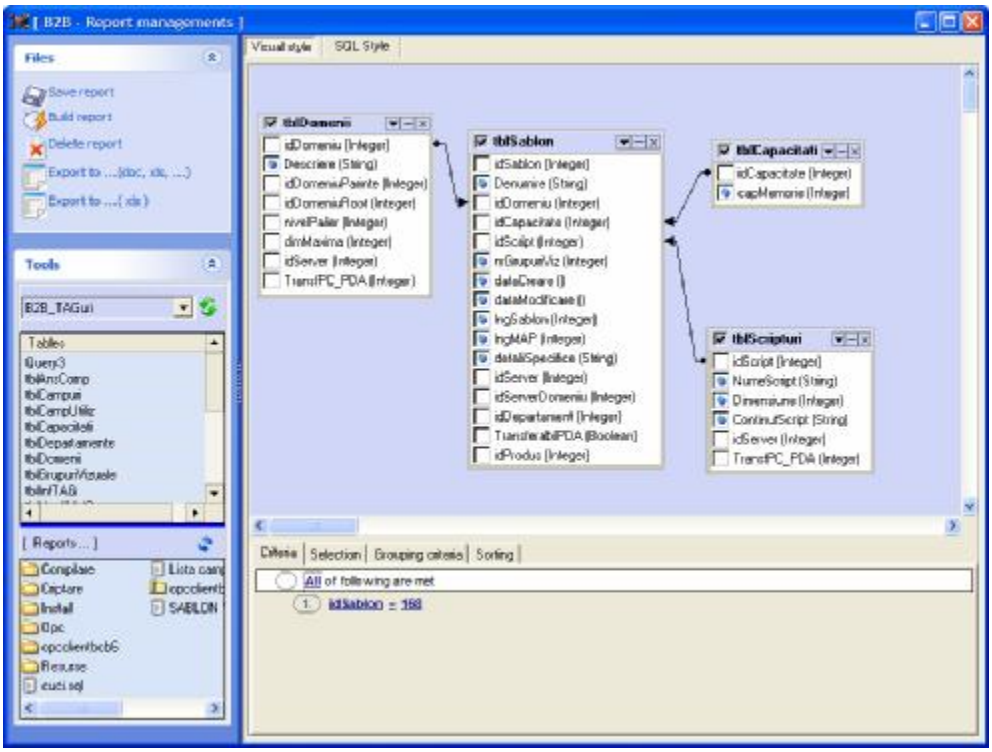

Figure 7. Report editor.

Into the page „Display event(s) settings" (Figure 9) we can establish some events that will be displayed on the WEB page (for example, authorized tags, unauthorized tags, modified fields, memorizing tag content into gate memory an so on). The user can also consult all events by time and date as we can see in Figure 10.

For every local WEB server (for each company) it is necessary the completion of all data regarding the company, including some additional data such as: number of employees, the income from previous year and so on. The admin user can create local users and groups of users, with corresponding read/write and other specific rights. Also we can record some other kind of data such partners companies with their profiles and some other useful information regarding specific partner information. Some user categories can establish the products that a company is selling and also can verify the stocks, etc.

Transponders | Events | Account | Home | Admin

HCCG - High Complexity Control Gates

Parameter name	Parameter value
Name	Main Entrance
Server IP	192.168.200.150
User IP	192.168.200.80
User Name	Administrator
User E-mail	administrator@adresa.ro

Figure 8. The main page of the web interface.

Transponders | Events | Account | Home | Admin

Show Event Settings | Show Events

Choose the event types for which you wish to receive notifications:

Save selected | Select none | Select All

Index	Event Type	Choose
1	Authorized transponder	☐
2	Unauthorized transponder	☑
3	Expired transponder	☑
4	Transponder moved too quicly from the readre's field	☐
5	Transponder content saved into history memory	☐
6	Wrong transponder modification command	☐
7	Command queue is full	☑
8	Transponders to be saved into history queue is full	☐
9	Alarm[i]	☑
10	Transponder field(s) modified	☐

Figure 9. Display event(s) settings page.

Our software platform is providing a system that allows establishing partnership between companies, to make some orders to other companies and so on. The WEB platform accepts both registered and unregistered users. In addition is allowed easy administration and organization of: company specific data, partners, products (Figure 11), etc. This data can be managed and monitorized by company-registered users and delivered to the final user. The intuitive interface allow to the users to be productive by performing some series of interactive activities like: hierarchical navigation, detailed web pages and so on. The software platform is flexible enough allowing reports and data visualization as

wished by authorized users.

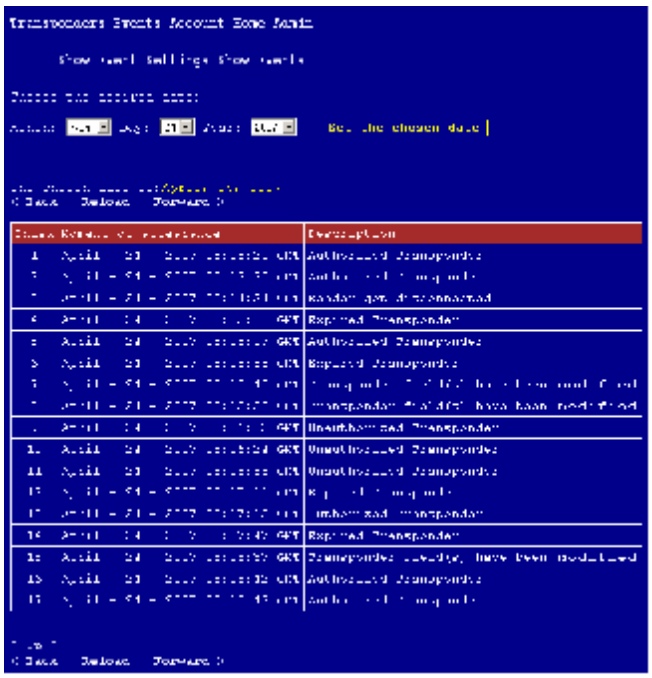

Figure 10. Events page.

The software platform includes the automation of transactions and simplifies the relations between two or more companies that are in a partnership relation. Product promotions are a key vehicle in retail, especially for consumer packaged goods (CPG) companies. A considerable amount of money is often spent on each promotion. Through the power of RFID_B2B platform, retailers and manufacturers can easily gain the visibility and intelligence required to monitor and analyze the day-to-day success of a promotion. From high profile promotions that involve special manufacturer-sponsored displays to retailer-created programs that promote new item son the store shelves, RFID automates the collection of the considerable amount of data required to maximize the sales and revenue opportunities related to promotional programs. Also, we have to specify that the WEB platform was designed very carefully regarding relations with potential clients, relations between partners so that both categories (clients and partners) will be maintained happy. These aspects are very important in maintaining a good relation with clients/partners and evaluating their satisfaction.

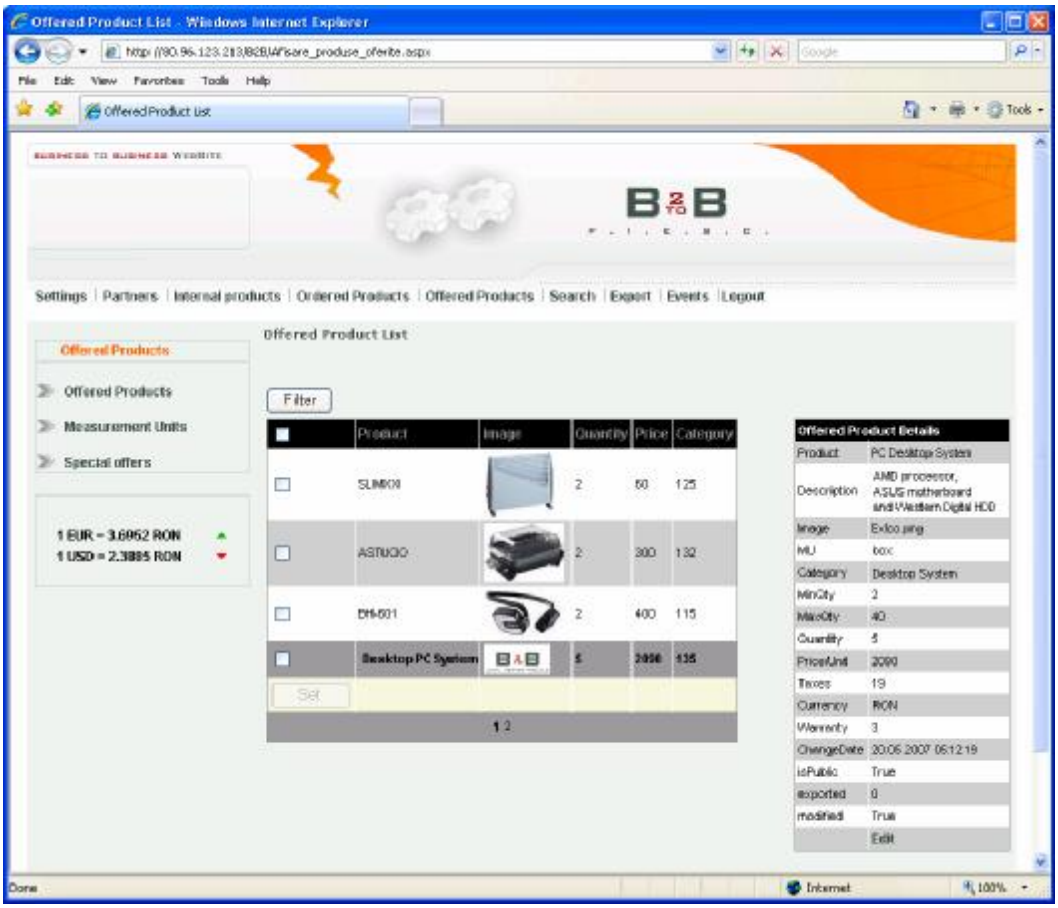

Figure 11. Product page.

V. CONCLUSION

By using RFID technology into a WEB B2B software system, we developed a complex platform that offer to the users superior services to classical B2B sites that provide:

- better interaction between clients and companies, services developed in order to improve clients loyalty and to improve sales;
- permanent presence of companies into a virtual market, providing the development of registered companies;
- exposition and promotion of products/services in a permanent virtual show-room, with a ideal promoting space, thus providing and creating easy access to market;
- accurate evaluation of the market demand and better management of the stocks;
- error free environment regarding costs by using electronic data;
- removing the necessity of intermediary agents/companies;
- fast access to market information, providing therefore a growth of information density between participators to the virtual market both qualitative and quantitative.

The software platform we developed is fluid, flexible and dynamic, since while researching and developing we take in consideration multiple aspects like RFID technology integration, data and information security, in order to provide a correct relationship that later will be established between business partners.

In conclusion the software system we described by now is a product of a society that relies on information and knowledge and which, in near future, can be a solution for some problems related to globalization process.

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