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OPTIMIZING CAMPUS ACCESS AND SERVICES USING RFID SOLUTIONS

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Abstract. *This paper presents a modern RFID system for campus access and facilities. The system works in 13,56 MHz range, according with ISO 15693 standard. An innovative access method using data blocks instead of searching ID card holder in a database is presented. Besides access control, the system can also provide: cashless vending for student restaurant, parking, laundry, copiers, cafeteria services, library check out services, logical access control to online research and other digital resources, automatic access to students events and activities, transcript of academic record.*
Keywords: *RFID, access control, transponder, campus, services.*

Introduction

Access control systems employing contact and contactless cards are already in use in many student campuses around the world. Moreover, there are many other services of equal interest to the whole academic community such as the access to electronic library resources, Internet resources, parking services, cafeterias and catering, copiers, laundry or bookstores. In spite of their great diversity, it is essential that some of them be round-the-clock services seven days a week. Another important issue is the security level of the whole campus because it needs to be carefully differentiated. Dormitories and special research laboratories should benefit from higher levels of security than bookstores and cafeterias. Given the great diversity of the in-campus services using access and control systems, one-code identity cards are not the optimal solution. The key to the problem is represented by the new Radio Frequency Identification (RFID) which can support contactless cards with memory and even allow the storage of much more user data. Conventional access and ID systems use magnetic cards, bar codes, proximity cards or radio remote control. The card or the tag designed for the personnel often contains a unique ID number. The access is granted if the ID is found in the reader memory or in the database stored in one or more PC connected to all readers. Few simple access systems are using only one ID number for all cards or a remote control, which transmit a signal on a dedicated frequency and/or a unique code. Such systems cannot identify a specific user.

The modern access control RFID systems enable complete hands-free access control. Tags or cards can be read up to 1,2 metres from the HF reader (even 12 m for a UHF reader), which usually eliminates the need to handle the tag or to walk very close to the reader [5]. This freedom is particularly important to handicapped workers, staff carrying packages, and during bad weather.

Many RFID readers can be connected to the access control computer through wireless communications. This eliminates the need for long wiring runs and allows a reader to be easily re-positioned or moved as needs change. The RFID access control system can report any unauthorized access and issue an alert to the host software. In addition, it can be used to trigger cameras and video recorders in order to capture unauthorized or authorized access in real-time [1,6].

But the most important advantage of a RFID system is that we can add or replace a lot of information on card or tag because we can write the card (tag) memory, even at a gate reader. We can easily change the access rights; we can introduce in memory many accounts for a lot of campus services or medical information for emergency.

The trend in the RFID access applications will be in the areas of integration tools and systems solutions. The RFID system can also control a lot of sensors (proximity, fire, humidity, smoke). The authors have presented few significant results in this area [7].

RFID in brief

Radio Frequency Identification – RFID - systems are using readers and cards or tags. Data is stored on an electronic data-carrying device — the transponder. The power supply to the data-carrying device and the data exchange between the data-carrying device and the reader are achieved without the use of galvanic contacts, using instead magnetic or electromagnetic fields. The underlying technical procedure is drawn from the fields of radio and radar engineering [2].

RFID systems use passive and active transponders. Active transponders are used for long-range applications but because a battery is included, their cost is much higher. Passive transponders do not contain a proper source of supply, the necessary energy for functioning being drawn out of the electromagnetic field of the antenna of a reader to which it is connected, placed in close vicinity, but with no electrical contact between transponder and reader. In order to obtain this energy out of electromagnetic field, the transponder uses an antenna equivalent to a resonance circuit consisting of coil and capacitor, circuit tuned to the frequency of electromagnetic field issued by reader. Magnetic field lines issued by reader antenna cross coil turns inducing an electric signal rectified and internally stabilized on the chip and then used for the entire transponder supply (figure 1).

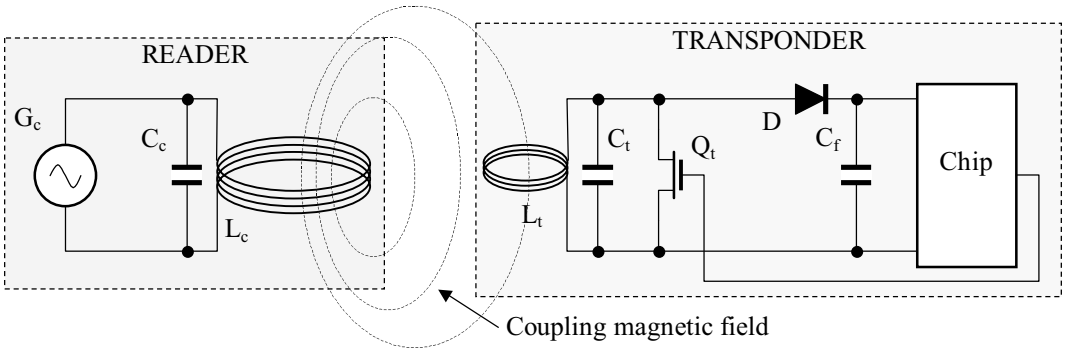

Figure 1. Energy and data transfer between reader and transponder

Communication between transponder and reader is realized through the same electromagnetic field used for supply. Thus, reader transmits interrogation signal and transponder answers communicating stocked data in its EEPROM memory. The communication method used for most transponders, which activate in the HF and UHF field, especially on the 13,56 MHz frequency or in the 862-870 MHz interval, is the so-called „load modulation". The LC circuit equivalent to the transponders antenna resounds on the f_0 frequency. The generator, at the reader's signal, injects power in its antenna (a frame-coil). The power, therefore the field created by the coil, is with a frequency which varies, linearly, from $f_0 - \Delta f$ and $f_0 + \Delta f$ ($\Delta f / f_0$ = 0,08 ... 0,15). When the transponder is in the magnetic field created by the reader, the energy absorption towards the resounded circuit at f_0 frequency takes place. This absorption, rather small, is nevertheless perfectly detectable, as a tension drop at the inductive coil terminals (the reader's antenna) or as an increase of the power through it. What really happens is a drop of the charge resistance equivalent at the amplifier's terminals which supply the reader's antenna. In order to send data from transponder to reader it suffices that the LC circuit be out of tune in accord with the issued data. Thus, the signal at the entrance of the reader's antenna will suffer a

mild modulation in amplitude. Nowadays, this amplitude modulation (AM) signal can be separated and demodulated to retrieve data. The principle is illustrated in figure 1, where Q_t ensures the LC circuit attenuation. For further details on communication proceedings please refer to [3,4].

In conclusion, RFID is a technology that enables wireless data capture and transaction processing at a very attractive cost. There are two main areas of application, defined broadly as proximity (short range) and vicinity (long range). Long range or vicinity applications can generally be described as track and trace applications, but the technology provides additional functionality and benefits for product authentication. Short range or proximity applications are typically access control applications.

System presentation

The figure 2 shows the typical elements of a simple one-gate RFID access control system.

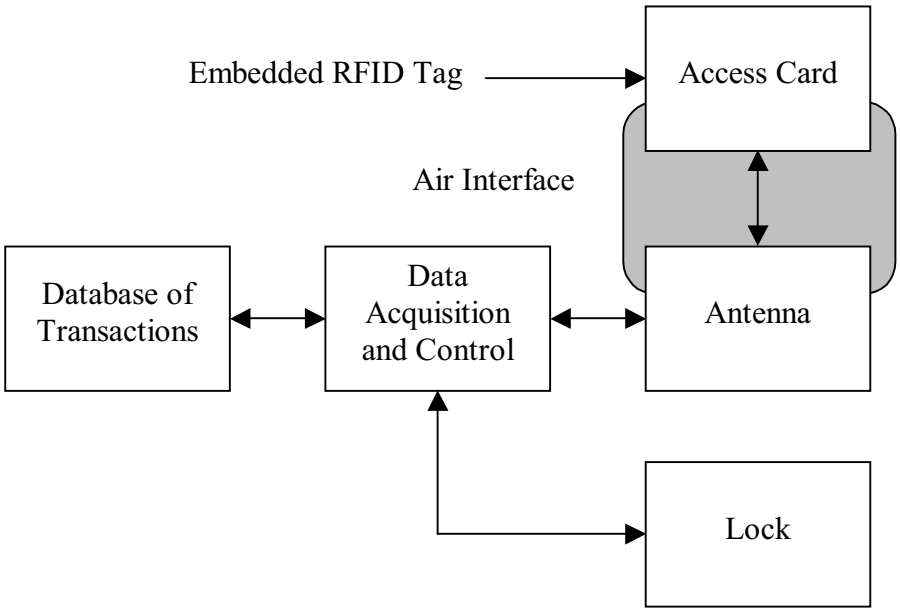

Figure 2. The access control system for one gate.

The entire access control system for a campus comprises a number of antennas used to interrogate RFID tags or cards; electronics for data acquisition and control; a lock or some other physical security feature under the control of the system; network integration of the distributed electronics; and a centralized database that records the details of the use of access cards. The RFID readers placed at each controlled gate contain the antenna and data acquisition and control block and, sometimes, the database. After scanning an access card, the system determines whether the individual is authorized to enter (or exit) and unlocks the barrier (if authorized to do so). A record of the transaction is (optionally) captured in the database. When the database is included in the reader memory, the authorization to enter is issued by the reader itself. This is the case of off-line systems and, optionally a history can be stored and sent later to a central database. In figure 3 the proposed RFID system for a campus is depicted.

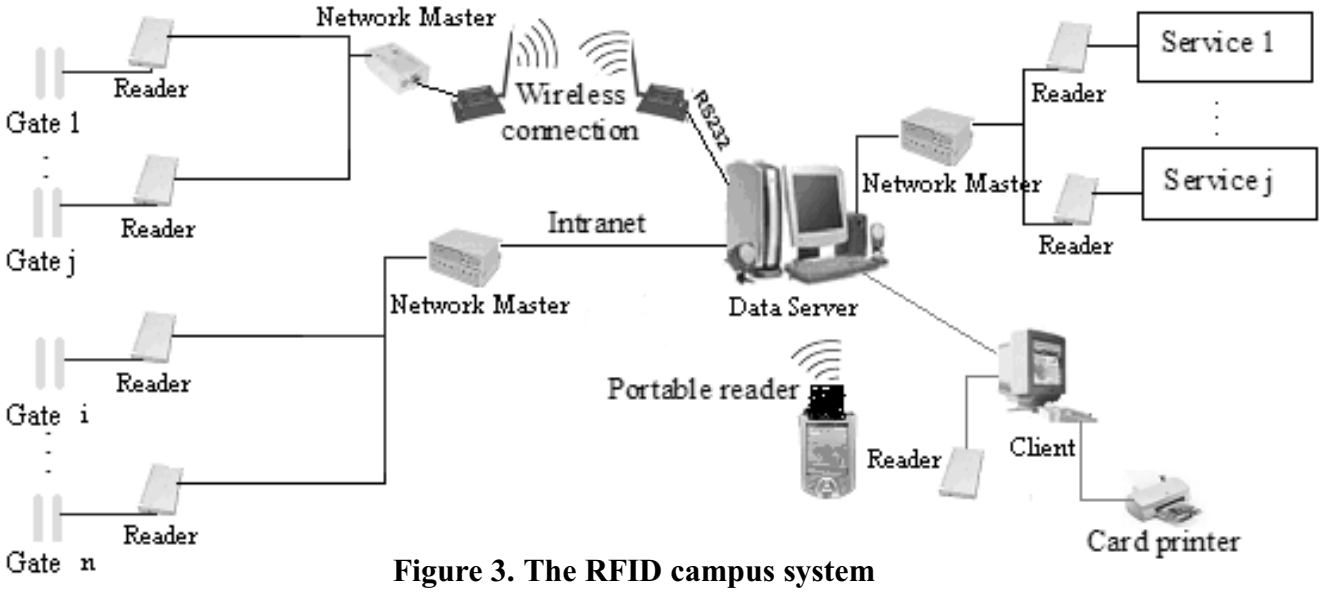

Figure 3. The RFID campus system

Besides lock control, the proposed RFID system is designed to manage many services in campus:
- automatic payment with the card in a campus restaurant/cantina (the card can be loaded at a central campus cashier);
- automatic payment for many services (the card can be loaded at a central campus cashier);
- medical control recording;
- school tax payment recording;

The most important feature of the system is the access method. Instead of using searching an ID code in a PC database or in a reader database at each gate whether the code is in a list and granting the access if so, we use a data block of 120 bits (for 120 gates) and check this block at each reader gate. Each bit in this data block corresponds to a specific gate. Each reader gate checks if the dedicated bit is "1". In order to grant the access to several gates, the system administrator will set to "1" the corresponding bits in data block.

Figure 4. Sample card

A similar method as for debit cards is used for meals payment at restaurant or other services (copier, parking a.s.o.). The RFID system has the possibility of writing and overwriting the card memory.

Other important advantages for campus management are the medical records, school tax records and transcripts of academic record. The recording of library information (books, time) can also be easyly implemented.
The RFID system (cards and readers) works on 13,56 MHz, according to ISO 15693 standard. For personnel and students identification and access to specific gates and services we proposed the ISO cards with Infineon my-d SRF55V02P transponder inside. The user memory for data storage is 2048 bits. One sample card is presented in figure 4.

The data stored in the transponder memory is organised as in table 1.

Table 1. Data stored in transponder memory

Data specification	**Bits in memory**
Personal ID	52
Expire card date	64
Data access block	120
No. card issued	2
Holder type (personnel/student)	2
Meal plan	2
Restaurant account	24
Service account 1 – 3 blocks	3x24
Medical record 1 – 5 blocks	5x65
Tax payment record - 10 blocks	10x92
Reserved for forbidden medicines	320
Reserved for future applications	150

An IDtronic ISO 15693 reader connected to a PC can be used to write data into transponders. We developed a generalized application to be used for write/read data into/from transponders. A model to be used on this PC for transponder information storage is depicted in figure 5.

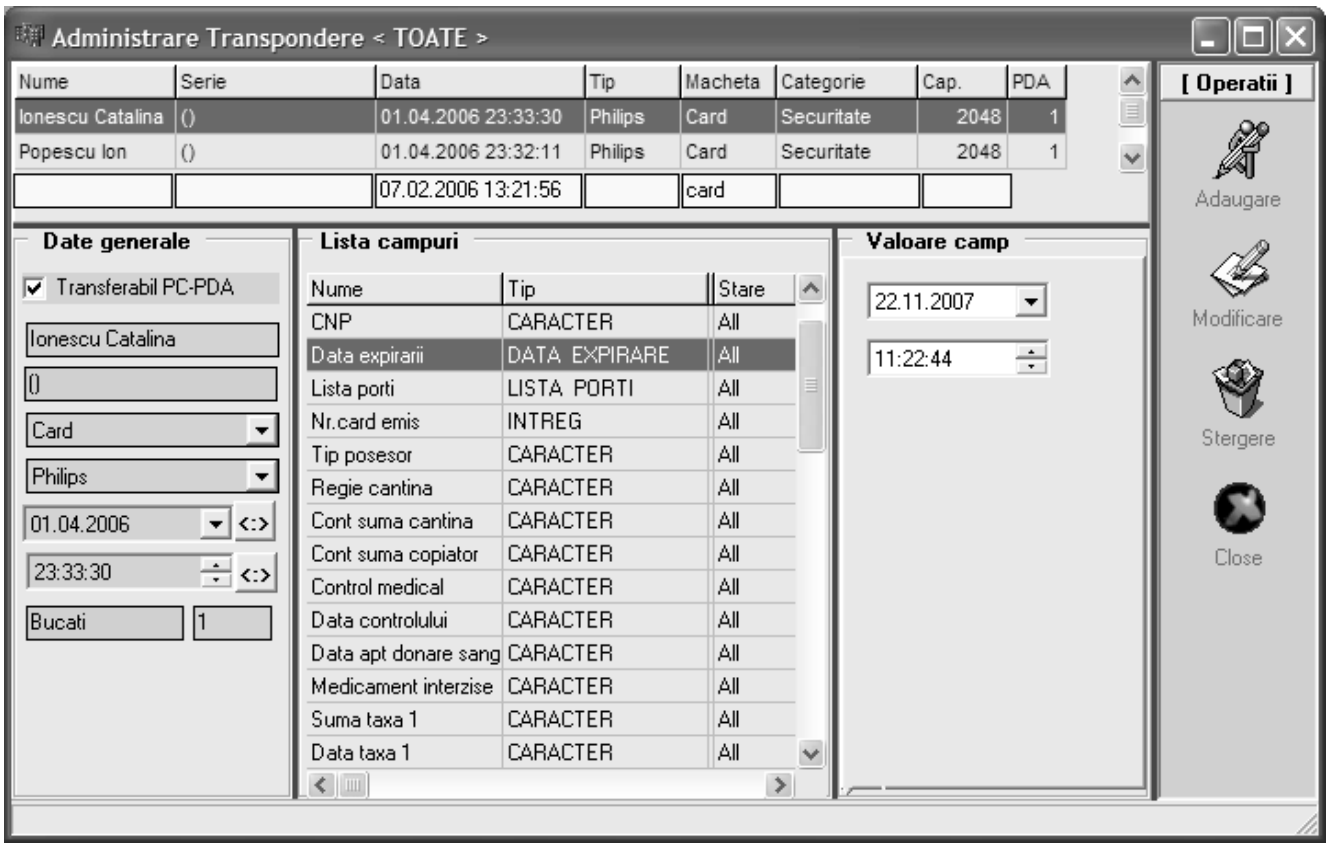

Figure 5. A model for transponder information storage

System benefits

The main benefits of the RFID system proposed for campus access and services are:

a) access through a gate is faster because it is granted without checking the PC database (on-line system) or a local database (off-line system);
b) easy changing of the access rights by overwriting the new data access block in transponder memory;
c) the card can be used as a normal debit card for all students' services (copier, parking, laundry, cafeteria a.s.o.);
d) possibility to record forbidden medicines to administrate to the card holder in emergency;
e) the possibility to record the periodic and compulsory medical investigation to the whole personnel;
f) the possibility of recording the transcript of academic record;
g) the possibility of managing the students' activity at courses, labs, library a.s.o.

Conclusions

In today's challenging business environment, securing the specific buildings or a campus through proper and easy-to-use access control systems is a competitive edge and advantage.
The significance of adopting contactless technology, as RFID, for access control cannot be underestimated when seen from the perspective of the multitude of opportunities to utilize that same card to provide additional capabilities and services on campus. Cashless vending for cafeteria services, library check out services, logical access control to online research and other digital resources, pre-paid parking facility access, laundry services, stored value debit purchases for student restaurants, bookstores and other campus retail facilities, automatic access to students events and activities, transit passes for on campus or near campus transportation services are just a few examples. Contactless smart cards can support all of these services and more.

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