

# Electronic Student Identity Cards at the University of Warsaw

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## Abstract

According to the regulation of the Ministry of Education, issued on July 18, 2005, until December 2007 all Polish universities should replace the old student identity cards by either the new paper ones or by electronic, with an embedded contact chip. Main Polish universities decided to invest in the new technology and issue electronic student identity cards. On October 1<sup>st</sup>, 2006 newly accepted students of Warsaw University got plastic cards, holders of student identity card, library card and municipal transport and parking ticket. Most of the tasks were finished almost in the last minute – hardware infrastructure for card handling was installed in the beginning of September, in-house produced software was delivered at almost the same time, orders from faculties for student identity cards were being placed in the central system throughout September, and cards were printed in a personalization center at the main campus. In this paper we describe how various practical problems were solved and how the final success was achieved.

**Keywords:** electronic student identity card, contact chip, contactless chip, student management information system, student admission.

## 1. Introduction

In Poland a student identity card plays an important role since according to law students are entitled for reduced prices in public transport services [4] and for many other discounts. Until 2005 cards were printed in paper with a black cover and two inside pages for photo, personal information and 12 slots for stamps showing the card validity. On July 18, 2005 the minister of education issued a regulation changing the card format. Two new formats were announced: a new paper version and an electronic card, with an embedded contact chip (see fig. 1). Universities were put under an obligation to replace old cards until December 2007.



Figure 1. Blank student identity card (both sides)

Main Polish universities decided to invest in the new technology and issue electronic student identity cards. From the organizational point of view this was a challenging project. At that time hardly any university had necessary hardware infrastructure, software, or experience with electronic cards. Only a couple of pilot projects were carried out before 2005 and only one higher education institution was using a campus card (only internally). The projects had to start from scratch.

In the beginning of 2006 a few conferences were organized by Polish companies offering electronic cards, printers, holograms, digital signatures, and software for campus cards. It was obvious that the new regulation opened a great business opportunities for many vendors. Universities decided to cooperate and try to cut costs by grouping purchases. 69 of them authorized Poznan Technical University to organize purchase of almost 1 million cards (three years supply). The whole procedure started in spring 2006 and – unfortunately – has not yet finished (in May 2007) due to repeated protests by one of the bidding companies. In the meantime some universities decided to make local purchases of smaller amounts. Warsaw University made a decision early enough to get cards on time, i.e. in September 2006. Universities which waited too long finally had to postpone the procedure and issue old cards.

Getting hardware infrastructure for the system of electronic student identity cards was one problem, the other being software. Any software for card personalization and managing is very sensitive to chosen hardware solutions: contact chip, contactless chip (if also available), printer, digital signature. It should also be well integrated with the existing student management information system. A few Polish companies offered campus card systems, but their software needed adaptation to university hardware infrastructure and none of them offered satisfactory level of integration with local information systems. Also by buying proprietary software we would inevitably have to pay cost of licenses proportional to the number of end users (which is quite high in an institution as large and as geographically spread as the University of Warsaw). Warsaw University has a lot of experience with producing in-house software – for itself and for other institutions gathered in MUCI consortium [5]. Thus not surprisingly the decision was made to produce in-house software for printing, managing

and prolonging validity of electronic student identity cards, well integrated with University Study Oriented System (in short USOS, see [3]), and supporting appropriate organizational procedures.

The description of these procedures, underlying processes and the supporting software is the main purpose of this paper. The hardware used in the project is shortly presented in section 2. In the main section 3 processes involved in card handling and underlying software solutions are described in detail. Some other issues concerning cards for the University of Warsaw are mentioned in section 4 and the second phase of the project is outlined in section 5. Conclusions are drawn in the last section.

## 2. Hardware infrastructure

### Cards

One of the main reasons for organizing a common purchase by the large group of Polish universities was to buy a relatively technologically advanced card relatively cheaply. The common expectation was to get Java card with support for PKI. It was also assumed from the beginning that in addition to contact interface required by the regulation, also the contactless interface will be needed for use in libraries, municipal public transport in the City of Warsaw and security access. However since the bidding lasted for so long, University of Warsaw organized local purchase of one-year supply of cards. In result multi-application dual-interface card was purchased with the following technical features:

- (a) Mifare Standard Card, MF1 IC S350 with 1 KB EEPROM memory (organized in 16 sectors with 4 blocks of 16 bytes each), and ISO/IEC 14443 A-2/3 contactless interface,
- (b) Emosyn TP 62 with 8051-compatible microprocessor, MaskTech Chip Operating System (MTCOS) Standard, 24KB EEPROM, 17 KB available memory, and ISO/IEC 7816-2/3 contact interface.

### Printers

Since card printers are expensive, the university authorities decided to organize one Personalization Center at the main campus, with two printers. The most challenging task is to print student cards for newly admitted first year students, in the approximate number of 12-15 thousand, in a short period after final admission decisions are made and the academic year starts. Since a student is entitled for many price reductions, every single one should get his card not later than on October 1<sup>st</sup>. The time is short, the numbers are huge, the printing is relatively slow. However it was calculated that with the good organization, work distribution, and two printers working in parallel the task should be finished on time. After the thorough research and comparison of technical features, thermal transfer print technology was chosen. Finally Fargo HDP600 (High Definition Card

Printer/Encoder) was purchased, with two encoders (accessing chips by contact and contactless interface), which in one pass encodes both chips and prints on two sides of a card.

## 3. Software

The main design decision concerning software was to produce it in-house, in order to integrate it well with the existing student management information system used at the university and cut cost of licenses which would be involved in any external proprietary software. The main processes were thus implemented through USOS interface, and they are described in section 3.2. However low-level software development kits (SDKs) for dealing with hardware and digital signatures were ordered from the printer, electronic cards and digital signatures suppliers, however these needed only single development licenses, which do not depend on the number of end users. These software libraries are shortly described in section 3.1.

### 3.1. Proprietary software used in the project

#### Read/write operations on contact chip

For low level operations on cards we used UniSC library developed by Unicard S.A. It is written in C and designed for Windows. It delivers all file system functions compatible with ISO/IEC 7816-4 standard, for connecting/ disconnecting to the card, handling dedicated files (DF) and elementary files (EF), reading chip serial number. It communicates with the card by protocol T=1 and can function with any card readers complying with the PC/SC standard.

#### Read operations on contactless chip

We use Omnikey CardMan 5121 dual interface PC-linked readers that read/write to both a 13.56 MHz RFID contactless smart card and virtually any contact smart card. Contactless smart card serial number is read using SmartCard API for Windows and ScardCL library from Omnikey.

#### Printing and card encoding

Fargo HDP600 printer has contact smartcard encoder GemPlus GemCore Lite Pro and contactless Mifare encoder GemProx C2. For printing and card encoding we planned to use Fargo SDK, which was bought from the printer supplier. According to specification it should have been available in a couple of languages, C++ included (C++ is our implementation language). However it turned out that C++ version doesn't work and American company developing software did not deliver patches on time (in fact no patches were delivered until now). Finally instead of high-level functions from SDK we had to use low-level drivers from GemPlus delivered with a printer.

### Digitally signing information on cards

According to the regulation, the information loaded onto the contact chip has to conform to a predefined format and be digitally signed by a person delivering the information who signs it on behalf of the university and is its legal representative. Format of the signed information complies with the ETSI TS 101 733 technical specification. For handling digital signatures and signing files loaded onto contact chip we used proCertum API from Unizeto Technologies S.A., supplier of digital signatures for use with student identity cards. Especially helpful was module UniLegit, which delivers functions dedicated to student identity cards, handling DF and EF files in a proper format.

### 3.2. Home-made software – processes and their software support

#### Installing digital certificates in the system

Information stored on the contact chip has to be digitally signed by authorized members of the university staff. In Poland there are only three Certification Service Providers and certificates are still relatively expensive. It has been decided that to cut costs only chosen representatives from university student offices will get certificates, usually two per one office – altogether 80 certificates have been ordered plus 4 for persons from Personalization Center who sign cards when they are printed and encoded.

Every valid certificate to be used for signing student identity cards have first to be installed in the system. Installation of the certificate delivered on the card is shown in fig. 2. The system guarantees that such certificate can be installed for only one person, and that only valid installed certificates can be used for signing student identity cards. It is also verified that the logged user is the owner of the certificate. Some extra functions are supported: displaying a certificate available on the card, displaying a certificate stored in the database, searching for a person for whom a certificate delivered on the card had been installed in the system. It can also be easily checked how many certificates are available and when their validity expires.

#### Placing orders for student identity cards

In August and September the most logistically difficult task was to gather in the system personal data and photos of all newly admitted first year students and to place orders for printing their student identity cards. The approximate number of new students is 12-15 thousand. Two important decisions were made which substantially rationalized the process. First, students were delivering the data by themselves, entering it into the student admission system used in the University of Warsaw [6]. The new step in the procedure was to load a photo to the system. A detailed instruction was prepared, explaining how to make a photo at home with digital camera, or scan

it, or get it from a professional photo maker in an electronic form.

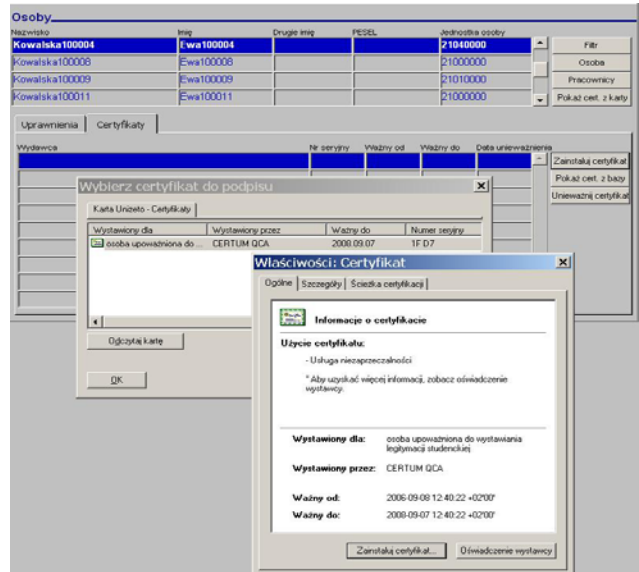


Figure 2. Oracle form for installing certificates in the system

Just in case one helpdesk was installed in the central campus of Warsaw University, with a digital camera and a scanner, but generally candidates performed the task quite well. They also had to print from the admission system an application form with the personal data and the photo on which they had to confirm with the hand-made signature the validity of data and photo to be printed on the electronic card (taking responsibility for the delivered data).

The second decision was to make employees of the student's offices responsible for double-checking quality of the data and ordering identity cards. Both tasks were performed in USOS. After admission decisions were made, data of the qualified candidates were transferred from the admission system to the student management system. This process was initiated and monitored by employees from the student offices, who controlled validity of data and quality of photos. Data gathered in the system could be – if necessary – compared with paper documentation. Then with a couple of clicks they could order printing of identity cards (see fig. 3).

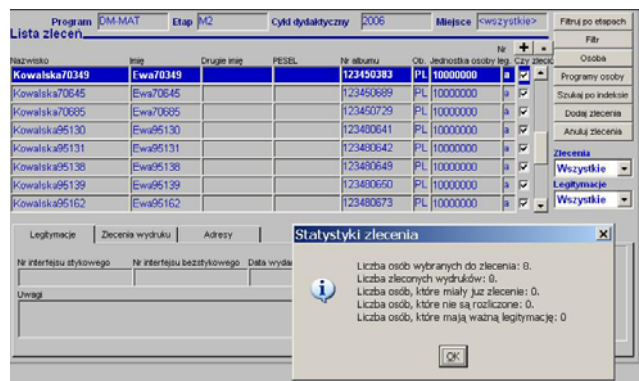


Figure 3. Oracle form for ordering identity cards

Oracle forms were designed in such a way to help with data control. All data needed for the student identity card (personal data and the photo) are displayed in one place and can be viewed with one glance. The system helps with controlling completeness of data and its consistency, e.g. cards can only be ordered for active students, with no valid identity card and no pending request for a card. As can be seen in fig. 3, the system accepts collective orders (a column with check flags on the right), but then verifies every single case, and when the operation is finished, displays a windows with statistics showing how many orders where accepted, how many rejected and for what reasons.

Why the described solution fits the needs so well? In summer months on one hand student identity cards have to be printed promptly to make sure that all of them will be ready before the start of the academic year. On the other hand, however, candidates often change decisions – they apply, cancel application, re-apply to another study program. It is very convenient that these changing decisions can be immediately entered to the system, pending requests cancelled, new requests delivered, stored information updated. All these tasks are performed in students offices. In the Personalization Center valid up-to-date orders are available and new identity cards can be printed with no delay. The up-to-date information is available in the same information system to all who need it. That level of integration and information availability could not be achieved with any external software.

There are many ways of filtering displayed data: pending requests, cancelled requests, valid student identity cards, cancelled student identity cards, etc.

The quality of photos was the most difficult problem to cope with. The main flaws were photos with wrong proportions and too pale. Unfortunately a place on the card for photo has very strong guilloche, which is a bad background for photos with worse quality. The card supplier was asked to change it on the next load of cards (in the limits admitted by the regulation).

### Printing student identity cards

The important aspect of the whole process is that ordering cards and printing cards can be performed in parallel. When the employee of the Personalization Center opens the Oracle form, he can see all pending requests grouped by faculty (see fig. 4). He accepts some of the positions on the list and starts printing. After one load is printed or at the end of the day, he prints paper report, and stores loads of printed cards with the reports, separately for each faculty. These loads are later collected by authorized employees of the faculties (also recognized in the system) to be delivered to the appropriate student office.

In the same interface all data to be printed on the cards are displayed. This is the last chance to find any inconsistencies so through the same interface a pending order can be cancelled and the reason for such decision

stored in the system. Such cancelled order is immediately visible in the interface of student offices, where data can be corrected by the employee. Such actions do not delay printing of other cards. Also the list of printed cards is immediately available to every one using the same system – faculties can promptly send employees for collecting waiting loads of print-outs.

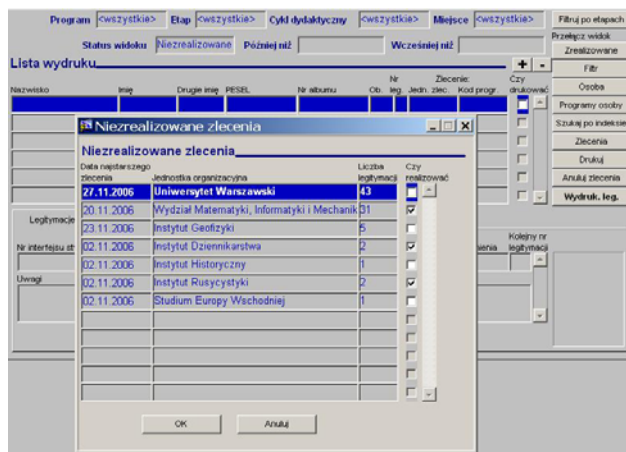


Figure 4. Oracle form for selecting pending print requests

### Prolonging cards validity

Validity of the student identity card is written in the EF structure loaded on the chip. It is also denoted by a hologram for the new semester which is glued on the back side of the card (see fig. 7). The main requirement for prolonging validity is that student has fulfilled the requirements of the study program and has been promoted to the next stage. That means that this operation can only be carried on in the context of the program – student may be active on one of his programs and not active on another. The system checks whether this requirement is fulfilled and also checks whether the employee is authorized to prolong validity of the card in the context of that particular program. If a student obtained a card from one faculty and then changed the program and moved to another faculty that new faculty becomes authorized to change validity of his card while the old one loses this possibility.

This decision has strong and positive consequences – faculties get motivated to timely update in the system information about student’s progress, otherwise they won’t be able to prolong validity of the cards.

How it works in practice? The old procedure was very quick – putting stamp on the paper student identity card. The new procedure doesn’t last noticeably longer. However there are more actions to perform, so extra support is needed. Let us assume that a student enters the student’s office. He inserts the card into the contact card reader. The employee pushes the button ‘Search for a card by a contact interface’. Immediately the student data appears on the computer screen. The default new validity



date is already displayed on the screen. Digital certificate of the employee is already present in another reader. Now the employee selects the proper study program (if there is more than one) and pushes the button 'Prolong card validity'. It takes a while: student's progress is checked in the system, data is read from the card, new validity date replaces the old one, it is verified the the operator using the system is the owner of the certificate available in the card reader, data is signed with the digital signature and stored back on the card. The information in the database is updated. Card is now taken of from the reader and new hologram stamp is put one the back. This procedure lasts a little bit longer, but the quality of the process is higher – no unauthorized operation is possible, the detailed information about the status of a student identity card is available in the system on demand at any time.

Extra functions are available in this interface. A certificate used to sign the student's data on the card can be displayed (see fig. 5). Student can be searched in the system by a serial number of the contact chip (as in the described case), by serial number of a contactless chip (described in section 4), or by bar code (this last option is used in libraries, which possess appropriate bar code scanners). Student identity card can be cancelled and a new request for the card issued – this will be performed in case a student informs about the stolen or damaged card. New card issued for the same student gets the following internal number ('a', 'b', etc.). A card is also cancelled in case a student returns the card when he leaves the university.

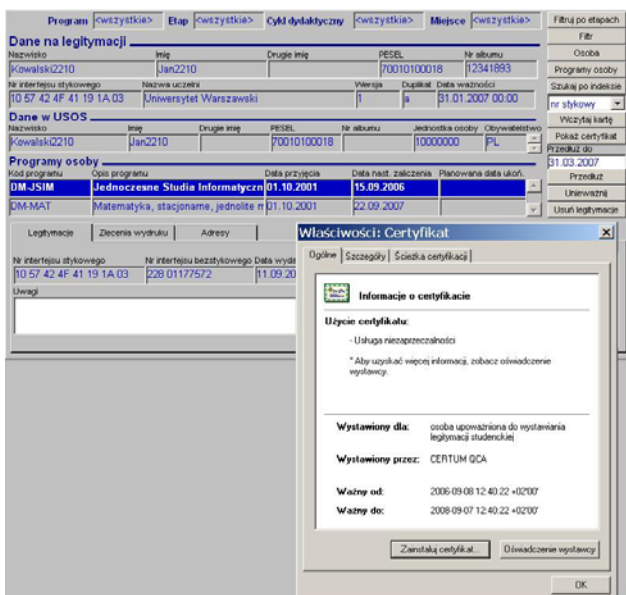


Figure 5. Oracle form for checking certificate on the identity card

#### Printing student identity cards for older students

The older students should have cards replaced until December 2007. Not much time is left, especially when you talk about approximately 40 thousand students

(altogether there are about 50-60, but first year students already have electronic cards, and fifth year students should leave university before December). Personal data of these students is already in the database, only photos should be added. The student is supposed to bring a photo in an electronic form to a counter opened in the computer lab, there this photo will be loaded straight to USOS and application form will be printed. The signed application is then delivered to the student's office. The printed identity card can be collected from the same office after a day or two. Students were encouraged to replace their cards possibly early, but they choose the exact moment by themselves.

#### 4. Other aspects

One of the main requirements was to adapt a new student card for use in the main university library and smaller faculty libraries located in various university buildings. Libraries have already been using magnetic cards with card codes which identified card owners as library users. It was obvious from the beginning that new electronic cards should also carry bar codes. However to advance technologically the applied solution it was decided that the cards would have Mifare chip with contactless interface and the unique serial number of the chip would become a user unique identifier in the library system. Librarians from various Warsaw higher education institutions gathered to discuss and choose a format suitable for all. It was recognized that the numbers should have at least 11 digits to make sure that they would not interfere with the already issued library cards. A special conversion of 4 bytes of the serial number into 11 digits number used as bar code was designed. These 11 digits are grouped into two sequences separated with a space, one with 3 digits built from 8 most significant bits of the serial number, and the other with 8 digits built from the remaining 24 digits of the serial number. Each group of digits is supplemented with insignificant zeros on the left. The chosen system also complies with the requirements of the municipal public transport in the City of Warsaw [4], which since many years had used Mifare chip as holder of the metro, tram and bus ticket and Mifare serial number as card identifier (in fact this separation of 11 digits into two sequences was their requirement). So obtained 11-digits representation of the serial number is printed on the card as a sequence of digits and in barcode 128 format (see fig. 6).



Figure 6. Mifare serial number as 11 alphanumeric digits and in barcode 128 format

There used to be long queues in the main university library every year in the beginning of the academic year. Students were waiting in line for a library card. This October for the first time there were no queues since students didn't need any extra card but a student identity card which was given them on the first day of the academic year. Librarians were the main benefactors of the new technology.

City of Warsaw which supervises the public transport system gained in two respects. First when a student identity card is a holder of the transport ticket the standard city card is not needed – this card costs about ¼ of the cost of the student card but by law it has to be distributed for free. So the city gains financially since students form the numerous group of city transport users. The second positive aspect is that now the holder of the city transport ticket at the same time authorizes a student for the reduced fare. No other document is needed. It is thus easier to check student's eligibility for the discount.

Five largest Warsaw high educational institutions have signed an agreement with the city, the other ones will follow. According to the agreement all new cards purchased by the institution are first transferred to the city IT specialists who prepare Mifare chip for holding the transport and parking ticket. Then cards are transferred to the Personalized Centers of the universities and are personalized. A student having such card can use any city kiosk to load a ticket. If a student leaves the university before his ticket expires he can have it transferred to a standard city card (the student identity card should be returned to the university).

When a student visits a student's office for some reasons, e.g. to get some paper certificate required by a bank or army, he has to identify himself. Now his identity card, which has to be presented anyway, will speed up the search in the university database – the system will read the serial number from the contactless Mifare chip and will start search for the student's record in the database. Many Oracle forms have this search option available (see Fig. 7, the last two buttons on the right in the small window in the middle).

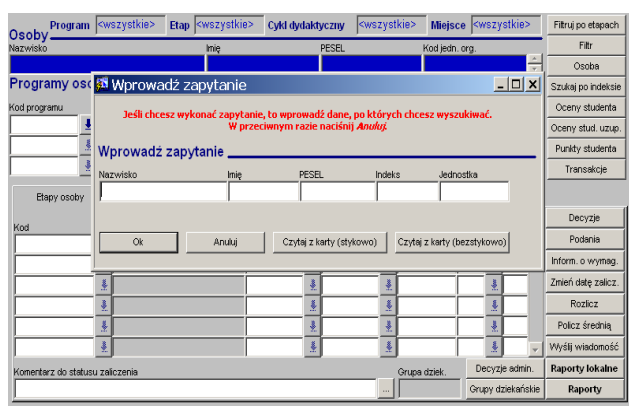


Figure 7. Oracle form with buttons to search a student by a serial number of contactless or contact chip

Two problems connected with the new technology should be mentioned. First the new card costs about 4-5 Euros which is substantially more than the old card. This cost is incurred by the student. But in case something goes wrong in the print the cost is incurred by the university. Especially in the starting phase this happened quite often.

Second the process of prolonging the card validity requires student's visit in a student's office which may become a bottleneck in rush periods. Some way of improving the procedure seems possible. The main problem is a hologram used for denoting card validity. Instead of holograms which are cumbersome to handle the validity date might be printed on the card by a special printer. Some European universities use such solution [1, 2]. In Poland first the regulation would have to be changed which at the moment names holograms as the only acceptable solution. If that happens students might prolong card validity by themselves using stand-alone printers attached to the system, at any time of the day. A card would be entered to the machine, a student would be recognized, his status checked and if all conditions are met the new validity would be written on the chip and printed on the card. There however remains a problem who would be signing digitally such cards handled in a self-service machine.

## 5. Support for diverse hardware and software infrastructure

Second phase of the project was carried out in spring 2007 with the aim to make the system available for diverse hardware and software infrastructure. USOS is owned by the consortium of 24 (as in May 2007) higher education institutions. According to law each public institution is obliged to make purchases by choosing the best offer from all delivered by the bidding companies. Anyone may win, what means that USOS should support electronic cards, printers, readers, and digital signatures from various vendors. We have chosen the most popular solutions available on the market:

1. **electronic cards:** Emosyn TP 62 used as the first card for the University of Warsaw, but also Java GemExpresso Pro R3.2 chosen by many other MUCI members;
2. **printers:** Fargo HDP600 and Evolis;
3. **contact and contactless smart card readers:** numerous products are supported;
4. **digital signatures:** products of all three Certification Service Providers operating in Poland are supported.

Universities may also have various preferences concerning the utilization of the blank rectangle on the reverse side of the card. Printing on the both sides is more expensive, so some decided not to print the bar code on the reverse. Those who want the bar codes may choose among various numerical identifiers: Mifare serial number (the most popular solution), student number or some externally delivered number (e.g. imported from the

library system). Bar code may be printed in 128 A, B or C format.

Platform chosen for a particular installation of USOS is described in a configuration file and various technical solutions may coexist in the same installation (e.g. the University of Warsaw will soon start using Java cards). This flexibility of software should help universities in getting good offers from product vendors and choosing optimal solutions for local needs.

## 6. Summary

The December 2007 is approaching quickly but the University of Warsaw and other universities using USOS are ready for it and should manage to replace old student identity cards with the new electronic ones on time. The academic year 2006/2007 was for many the time for the challenging project of introducing the modern solution to university daily life. The success was possible due to a couple of reasons. The main important one was that we managed to avoid a trap present in many similar projects: to build software supporting new solutions incorporated into old organizational processes. Instead, we spent a reasonable time rethinking processes, imagining ourselves the possible variants, designing new solutions, and finally developing the supporting software. The first prototype version of software was limited from the technological point of view (that was compensated for during the second phase of the project) but from the very beginning was well integrated with the student management information system used at the university and naturally incorporated into daily processes carried at student offices. That would be impossible to achieve with any software delivered by an external vendor.

There is still a lot to be done. Electronic student identity card opens many possibilities. We start thinking about new applications to be hosted by the card, like access control to student dormitories, computer labs and other university buildings, printing, photocopying, using vending machines etc. [see eg. 1, 2].

There are also plans to issue identity cards for employees. The problem is however that no nation-wide regulation is available yet. That means that on the one hand universities are free to choose any solution but on the other that such card would have the limited range. We think about using the employee identity card as a testbed for the solution with the reprinted date of card validity – if it works for employees, it might be later adapted for students.

## Acknowledgements

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