CampusXpress Solutions

Telecommunications Management

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1. Executive Summary

This project report gives an overview of the CampusXpress system and considers the feasibility of extending and upgrading the system. The components of CampusXpress system such as hardware, network, and organizational aspects are explained. Additionally, three possible extension and upgrade technologies currently available on the market are discussed. The solutions provided are swipe-card readers by Blackboard and CBoard, and Smart Card by Mac-Gray. Each system provides various applications such as vending machine, copier, laundry machines, etc. We not only describe the technological details of these solutions but also sketch out their business implications. We describe a business case for an extension of the current CampusXpress system to Hamburg Hall's vending machines and analyze the financials of introducing Blackboard Transaction system. The analysis reveals that Blackboard is a feasible solution for upgrading. However, based on experiences of peer universities the Smart Card solution does not yet seem mature enough.

2. Introduction

CampusXpress is a debit account with Carnegie Mellon University. Any student at Carnegie Mellon University can open a CampusXpress account and deposit money. The student then is able to use his student ID to authorize numerous vendors on campus and off campus to make deductions from this account. The main business partners are restaurants and stores. The purpose of this paper is to describe the technology that is currently used and to analyze the underlying policy and business issues. Furthermore, we will try to make a business case describing the economic characteristics of the current system. Secondly, we will identify possible technologies and business applications that improve the service for customers and business partners. This includes business cases for the possible solutions and final recommendations. Finally, we will try to leverage the findings to possible new technologies and applications that might be applied outside of Carnegie Mellon campus.

3. CampusXpress as a M-Payment Solution

2.1 Overview of Current CampusXpress at CMU[1]

CampusXpress is a declining balance account. Students can add any amount of money that they specify on the CampusXpress Application/Deposit form. Any person affiliated to CMU, be it a student, staff or faculty, is allowed to use this service. Students (or any other user) can pay in cash, with credit card, debit card or check. There is a non-refundable activation fee of $15. Then students simply deposit money in their accounts at the HUB. There are numerous restaurants and shops around campus and off campus where students can use their Student ID to authorize a payment from their CampusXpress account by presenting their ID cards at the check out or payment. The card is swept through an authorization terminal and the system gives access to an account management system, a piece of software by Diebold. After the identification is done, authentication goes to the POS terminal and the transaction is verified. The HUB records the balance in the student's account and in the CampusXpress system under their student ID numbers. Additionally, ID numbers are stored on the magnetic strip on the back of the student ID card. The amount of money left in the account is shown after every transaction, so students can always know their balance. If students would like to have the itemized statement they may request one and it will be available in the HUB within 3 or 4 business days. At the end of the academic year, students may request a refund of the remaining balance if it is over $5. Else, students may simply leave it there until the following year. The money in the CampusXpress account can be withdrawn only either in the emergency case or in the case the money must be withdrawn. In that case, students will be charged a withdrawal fee of $25 and their accounts will be closed. To reopen the account, the initial fee of $15 will be charged again.

The major players in CampusXpress are students, on and off campus stores (business partners), Carnegie Mellon University administrative staff and the Diebold Account System. In the next section, we identify the relations between these players and the

[1] The following chapters are based on interviews with staff of Carnegie Mellon and our own analysis. Fur Interviewee details please refer to Appendix.

structure of the system. In section 2.3, the brief description of the technologies used in CampusXpress system is given.

2.2 Structure and Data Flow Analysis of CampusXpress

The following description (1-8) is the summary of a series of actions up to the Point of Purchase (Interview with Rosemary Lewis at HUB):

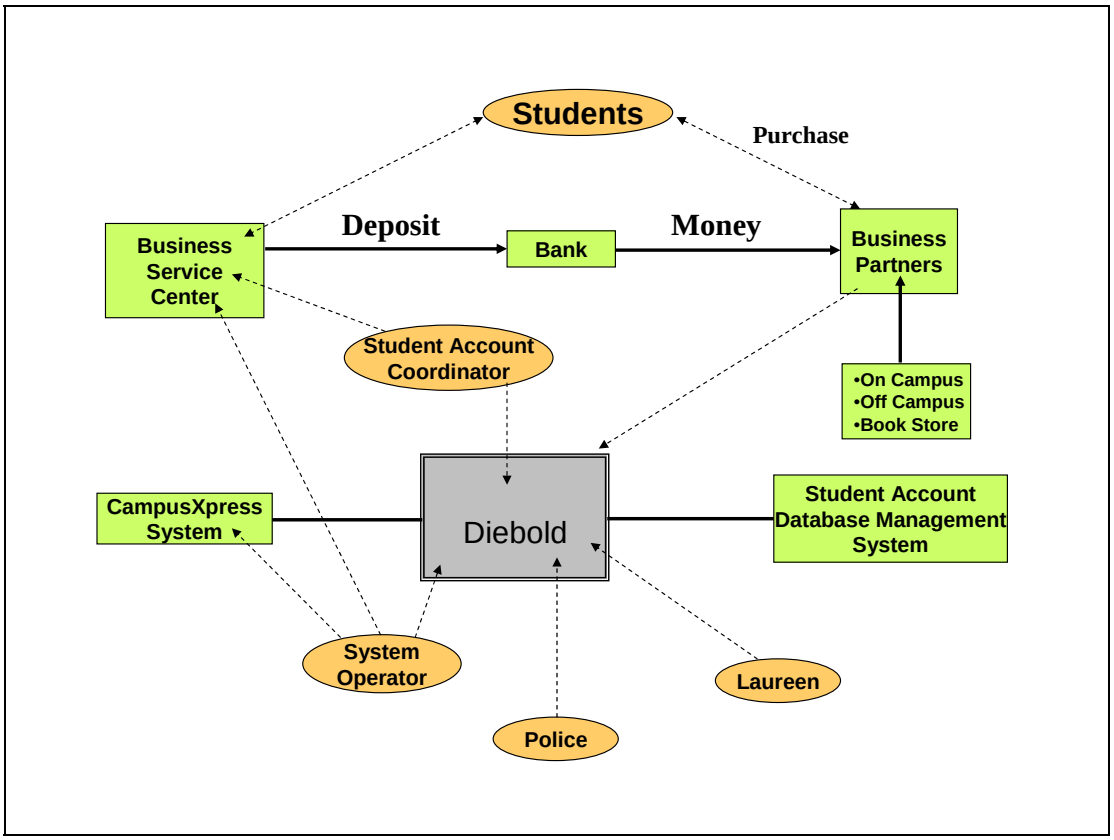

Figure 1. Structure and Data Flow between Major Players in CampusXpress System
(Source: Own Analysis)

1. Students fill out a form on paper at the HUB
2. Students decide how they pay (cash, check, credit card, debit card). During the springtime they can decide to get billed on their student account.
3. If paid by credit card, the HUB directly tries to authorize the payment.
4. After the authorization is made, the HUB keys in the information on the students into the Diebold system to open a patron account (a file that keeps track of all the future transaction and stores them).
5. The HUB also types in the demographic information about students and the amount of money they deposit. Despite the fact that the balance is not changed in the same minute, the HUB grants students access to their money as they walk out of the door.
6. The Student Account Coordinator requests the money on the student's account.
7. A data entry clerk keys in the necessary information, sends the invoices and adds the amount to the student's account with the university.
8. The money is forwarded to a deferred account which holds all of the CampusXpress funds in one single account.
9. Business partners debit this account when they receive the authorization by customers (students) and Diebold synchronizes the changes within the system.

Diebold is a database interface connecting student the account database and the CampusXpress system. The System Operator is responsible for Diebold on behalf of the Business Service Center to deal with any issues on the system. The System Operator also participates in the management of CampusXpress System. Once a purchase and sale occurs, all the records are transmitted to Diebold to be stored in the CampusXpress database and the Student Account Database.

If a student's card is defect, the purchase transaction can still be carried out by simply keying in the SSN. The HUB will issue a new card to the student. In case of displacing a card, the loss must be reported to either the HUB, any POS terminal on-campus, or to the

police. The police have access to the system as well. There are 2 numbers stored in the magnetic strip of the ID card.

1. Student's SSN
2. a 4-digit encoded number: the first digit is to identify student's card, which is one of numbers from 0 to 9. The rest 3 digits are used to identify the school (i.e. CMU, UPitt…). In case of loss the old card can be identified by its first digit and is invalid for further use.

2.3 Description of Technology

The major players in CampusXpress are students, on and off campus stores, Carnegie Mellon University and the Diebold system. The following description will focus on the pieces of hardware, the software and the means of communication between the different terminals and databases (Interview with Joshua Frederick, System Operator) A schematic overview of the technological network is presented in Figure 2.

The system of CampusXpress is quite old and is very far behind in the campus related service industry. The last major change in the system was in 1998, because it was not Y2K compliant. The current system is working on an OS2 server. The information is stored in a flat file system. The software is a sort of precursor to Oracle. The current system is CS Gold 3 using Oracle 7.3. The Business Service Center is planning to upgrade the system to CS Gold 4 with Oracle 9i.

Figure 2 describes how the players are connected and what technologies are used to communicate between players. The description is centered around CampusXpress which is only one of several applications in the Diebold system. It has 6 modems for dial-up connections. All off-campus stores use a Verifone access device which is similar to a credit card reader. When transactions are made, the Verifone device connects to one of 6 modems in CampusXpress System and accesses the system record. It uses UTI

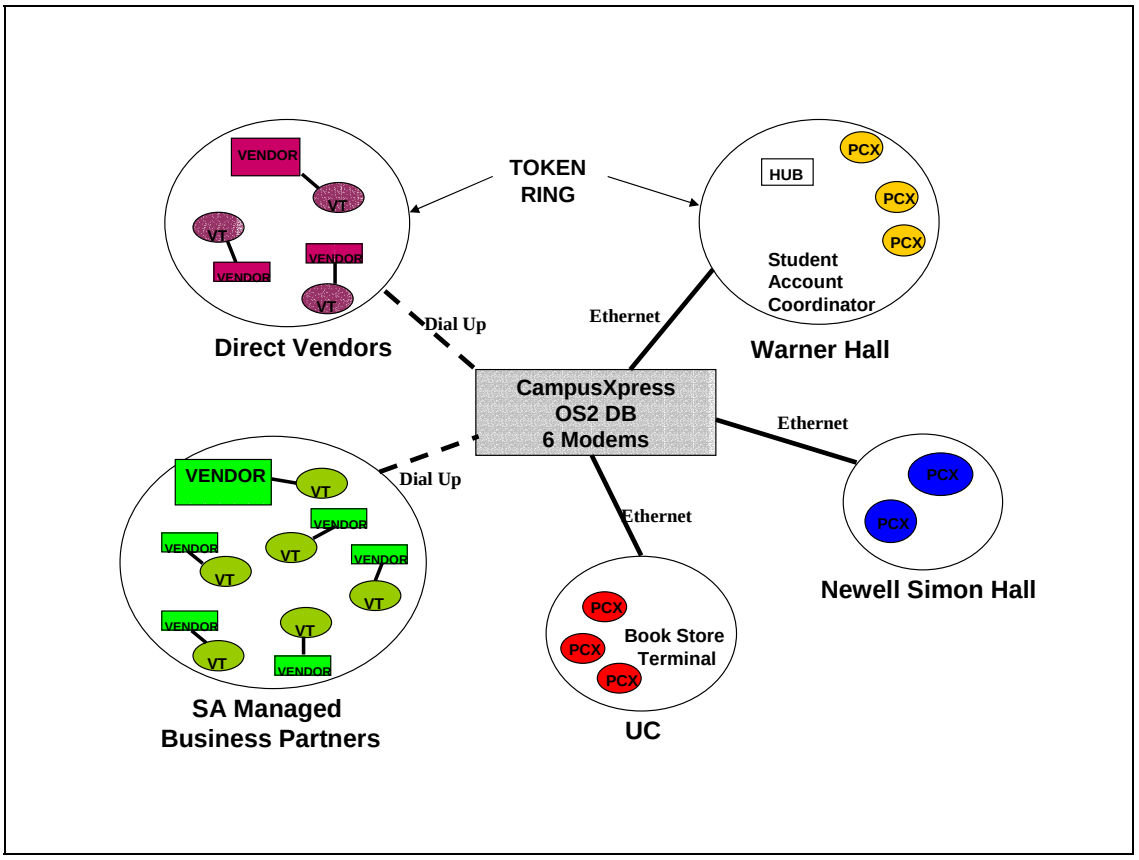

Figure 2. Schematic Description of Network between Diebold System and Vendors (Source: Own Analysis)

(Universal Terminal Interface) and transactions are treated in the same way as debit card by Diebold System. In case of on-campus stores, two different technologies are used to verify the account information. CMU book store has its own cash register system because of its special needs in reporting information. The connection system for CampusXpress is similar to the Verifone device but uses the local LAN of the UC. Other on-campus stores and restaurants use so called PCX terminals which are typically used in campus dining establishments. These POS terminals work in a IP network and are connected for whole day. Because each building in CMU campus has its own token ring, the bookstore registers or PCX terminals in the same building are connected in one token ring. This token ring is connected to CampusXpress System with Ethernet connection.

There are two possible security issues related to current CampusXpress system technology. One is about the ID card and the other is information transmission through dial up line. Diebold uses the student's SSN to authenticate to the system. Because the SSN is stored on the magnetic strip on the card and it is not encrypted this can cause major issues in case of loss. The management of BSC plans to solve this issue when rolling out the next system. A second issue is the potential insecure transmission over networks. The dial-up connection uses direct access through the modems, so there is no problem with that connection. However, all the university buildings are wired as LANs and someone might try to access the local PCX terminals which can be identified over the IP network. The System Operator explained that any intruder would have to be on the same hub, though, hence reducing the risk of eavesdropping.

2.4 CampusXpress Business Case

Out of the University's perspective, CampusXpress is basically a not-for-profit business model. Its major benefit is the increased security and convenience of students who do not have to carry any cash with them anymore. In other words, CampusXpress does not earn any profits by providing payment service. Carnegie Mellon University deposits money from individual student account and gets some interest from it. Additionally, each vendor is charged a minimal percentage of the transaction volume. These proceedings are use to cover the maintenance, upgrade and labor cost caused by the system itself.

About 2,500 students, faculty and staffs are using CampusXpress. Parallel to CampusXpress the university offers a similar system called DineXpress. Most of the 1,600 subscribers of that system are using both services. Every year, 1300 freshmen are registered on the meal plan. There is an initial, one-time enrollment fee of $15 to open a new account. Replacement of lost, stolen or damaged cards is subject to a $15 fee. No interests or other earnings are paid to the student account and no cash refund is made except student suspension, expulsion, graduation, or employment termination.

Off campus vendors pay certain percentage of turnover. From early times of deployment, the university has 5 direct vendors that are dealt with. There are about 30 other vendors off campus which have been acquired for the university by an intermediary called Student Advantage. Student Advantage as well as CMU again charge a small commission of the transactions. Another major source of income is the CMU Bookstore which has a high turnover with students using the card.

On the cost side, there are about $40,000 being spent on new hardware, software, maintenance and upgrades per year. Off campus hardware and software is managed by Student Advantage. Additionally, there are the labor hours by the different users of the system. This includes the Student Account Coordinator when opening the new system and doing follow-ups on wrong transactions, the HUB staff hours when opening the account, the police when managing lost cards and the time of the System Operator. Latter estimated that he spends about 20, 30% of his time on the CampusXpress system, which adds up to about $20,000 a year. Overall, we estimated the cost at about $100,000 a year. With about 3,000 users and an average transaction amount of about $1,000 per user (see information pamphlet HUB) there is a turnover of $30,000,000 a year. As stated before, there are plans being made to update and expand the system. Nothing concrete has come out, yet, but according to Joshua Frederick, system operator of CampusXpress, the university guidelines for investments are a ROI with a payback period of 2 years for small projects and 5 years for bigger ones such as CampusXpress.

4. Extending and Upgrading CampusXpress

3.1 Blackboard Transaction System[2]

Blackboard offers a choice of enterprise transaction processing software and related hardware solutions. The Blackboard Transaction System is available for either UNIX or Windows environments. Each edition offers core transaction functionality bundled into

[2] The following description is mainly based on the product information on Blackboard's website.

one complete solution, allowing clients to expand and leverage their investment on an as needed basis.

Blackboards UNIX Edition includes the following core bundled functionality (selected list of items):

- Debit Declining Balance
- Vending, Laundry, Copy
- On- and Off-Campus Commerce – Merchant Dial-up Terminal (MDT)
- Value Transfer Station (VTS)
- Meal Plan Administration
- Student and/or Staff Identification
- Point of Sale (POS) commerce

Some of the possible items include the following:

Unattended Readers for Vending, Copy and Laundry

- Vending Reader - Provides full currency and card transaction functions, allows for online authorization of all card transactions and displays messages and the cardholder's account balance on the 2-line x 8-character display after each valid vend. In case of error, the reader has a security feature that stores transaction details of up to 2,000 transactions. The reader automatically connects to the system again as soon as possible.

Vending Reader (Source: Blackboard.com)

Copy Machine Reader (Source: Blackboard.com)

- Copy Machine Reader – Have a swipe-through style card slot but also a keypad that allows account overrides or departmental charges to be accommodated. The reader displays the user's account info after each use and is also able to store transactions offline. Each reader provides the possibility to track sales activity by each reader location. Additionally, copiers can be equipped with currency acceptors.

- Laundry Center Reader - Eliminates laundry machine coin boxes and token acceptors. In its basic configuration, each LCR can support eight laundry machines. In its expanded capacity with Laundry Center Multiplexers, the LCR can support up to 64 machines across a laundry center network. The LCR also provides an interface for a Laundry Coin Acceptor (LCA), which is a coin mechanism housed in a strongbox. The LCA enables a laundry machine to be activated using coins as an alternative to the magnetic stripe ID card.
- Value Transfer Station - Make deposits, check balances, purchase visitor cards 24 hours a day.
- Activity Reader - Regulates access and provides count reports.

The Blackboard Transaction System offers a reliable and sophisticated application for powering commerce and access transactions including e-Debit processing, Web deposits and more. Blackboard offers a choice of enterprise transaction processing software and related hardware solutions to meet a client institution's specific needs.

Blackboard's system delivers up-to-the-minute, real time information, management and demographic capabilities because transactions from online readers are immediately logged to a central database. This provides a complete transaction audit trail and a wide variety of reporting options.

Blackboards Windows Edition includes the following core bundled functionality:

- Student Identification

Transaction System allows to provide users with identification cards and to track user data. All user profiles are stored in a central database, and user data can be imported from a variety of commercial Student Information Systems (SIS). By partnering with experts in the video imaging industry, Blackboard offers the latest in video imaging hardware, software, and services for the organization's distinct identification needs. Also, as a full service provider, Blackboard supplies organizations with customized user identification and debit cards, including card design and production assistance.

- Point of Sale commerce (dining, bookstores)

POS System enables users to make purchases across the campus from their campus debit accounts. Blackboard offers you complete control of point-of-sale operations. Point-of-sale keyboards used at locations throughout the campus can be configured and downloaded for daily use, and keyboard overlays can be replaced quickly and easily. The POS can even automate different point-of-sale keyboard settings based on time of day and day of week for seamless mealtime transitions.

Blackboard point of sale functionality includes:

- Campus debit cards
- Meal plans
- Privilege verification
- External tenders
- Cash
- Cash equivalency

- Self-service commerce (vending, laundry, copying)

On- and Off-campus commerce

Similar to what is already in place at CMU, this system enables on- and off-campus merchants to accept payments from the campus debit accounts. Blackboard Transaction System allows the university to extend the campus community into the local community and encourage users to use their campus debit accounts more frequently.

3.2 CBORD Transaction System[3]

CBORD is known as the world's largest supplier of food and nutrition software solutions, campus-wide ID card programs, cashless dining, and housing management systems. It is also the business which develops computer information systems for the administration of onsite food service, housing, access and privilege controls, and related auxiliary functions.

CBORD offers full-featured, integrated controls used to manage larger and more complex food and nutrition services, as well as cost-effective options designed to serve the needs of the smallest and most straightforward operations. CBORD's privilege control and cashless systems are industry-standard tools for managing individual and departmental privileges and accounts in any institutional environment.

CBORD's client base comprises over 3000 colleges and universities, large medical centers, small nursing homes, business and industry foodservices, recreational complexes, corrections facilities, restaurants, foodservice contractors, food manufacturers, and grocery distributors.

[3] The following description is mainly based on the product information on CBORD's website.

CBORD Window NT base system is represented by the following core bundled products:

a. Campus-Wide Card Systems and Cashless Systems: Odyssey PCS

CBORD attacks the point that every campus is unique, faces unique challenges, needs unique strength and sets up unique plans for the future. So, it has been serving the college and university market with Odyssey PCS, which CBORD believes to be the standard for campus-wide systems.

- 32-bit WindowsNT application
- Scalable n-tiered architecture
- ODBC-compliant database
- TCP/IP communications protocol
- Extensive administrative tools

As shown above, the Odyssey PCS for the campus market is a powerful Windows NTbased system that integrates all of your campus cashless activities & revenue generating transactions onto one card over your network. Odyssey PCS communicates campus-wide; creating a system that allows student and faculty to use a one-card solution for all their cashless needs. Odyssey PCS is ODBC-compliant. Used in the cafeteria, the student union, the library, vending machines, and anywhere a student ID can be found, Odyssey PCS can also provide funds to students and faculty at local participating vendors off-campus.

CBORD recommends the following minimum specifications for the network:

- Poweredge Server
- PIID, 550 MHz Processor
- Mouse
- Keyboard

- 256 MB RAM
- 1x6 HOT Pluggable Backplane
- 56k Modem
- 17/40X CD-ROM
- RAID 5
- 1.44 Floppy Drive
- 12/24GB DAT Tape Drive
- 3 9.1 GB LVD SCSI Hard Drives
- 2 Intel Pro 100 Plus Ethernet Network Cards
- Microsoft Windows NT 4.0 or More

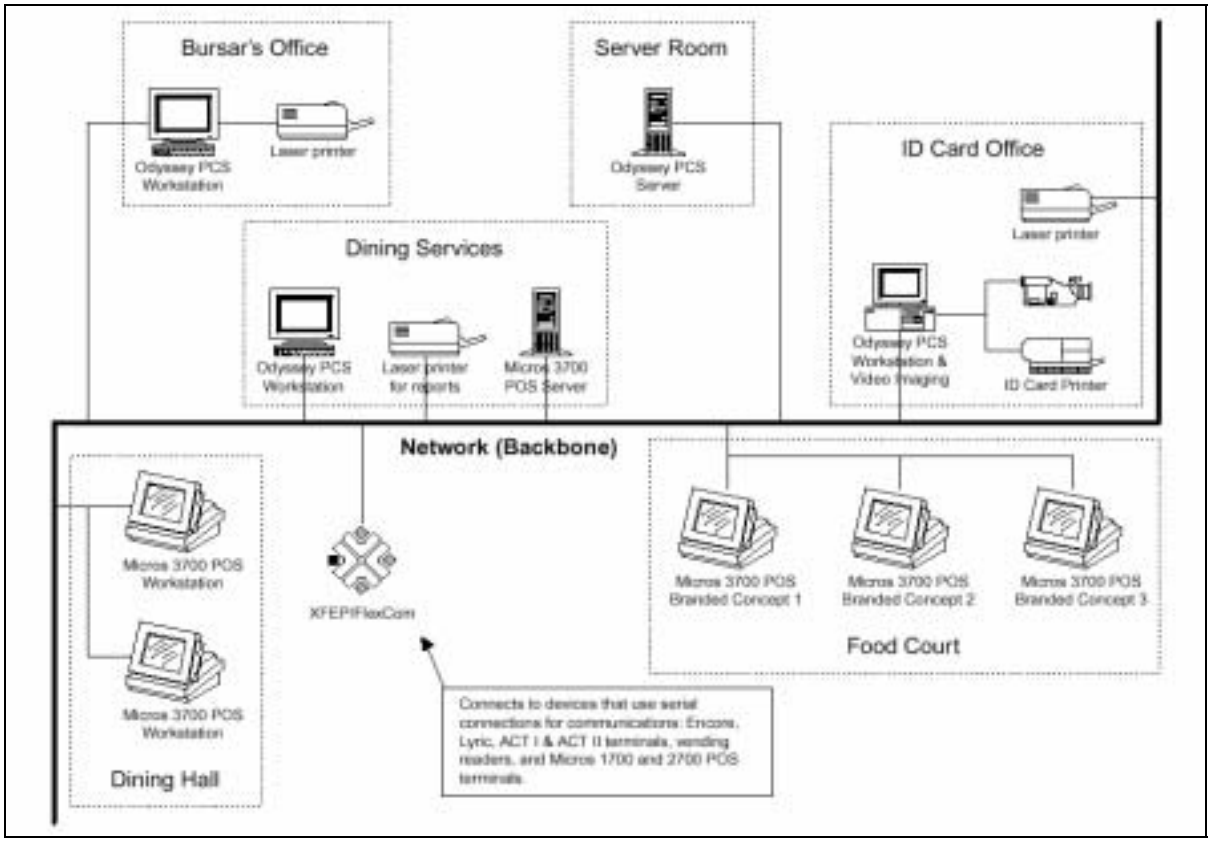

Figure 3. Schematic Description of Network Offered by CBORD. (Source: CBBORD.com)

b. OmniONE

OmniONE is a powerful, economical single computer privilege control system for small and medium-sized institutional environments with fewer than 5,000 card holders. It offers nearly all the features of advanced Privilege Control System people have come to expect from other CBORD systems. Its mouse-driven interface offers many features including task scheduling and reporting. The computer in this system acts as both transaction processor and file server supporting a network of up to 100 card reading devices. OmniONE also supports CBORD's real time interface, allowing you to exchange information with other administrative systems automatically.

Additionally, OmniONE supports hundreds of board and points plans and activities. It also coordinates communications with up to 100 "point of service" terminals, including online vending readers. CBORD offers OmniONE in both "corporate" and "college and university" configurations.

Features

- Economical one-card solution for small and medium sized institutions
- 999 plans and 999 activities, supporting over 1,000 terminals
- Intuitive window/mouse driven interface
- 5,000 card holders and 100 terminals
- Open-ended architecture design and upgrade path to OmniAccess
- Advanced Reporting Features including
  - True up-to-the-minute, real time reporting
  - Tracking accounts by ID and/or ISO bank number
  - Sophisticated patron and activity queries
  - Advanced custom messaging
- Safeguarded with smart UPS

- On-line troubleshooting
- Best support in the industry
- Store a year (or more) of data
- Any combination of on- and off-line vending
- Dial-up card readers for remote locations

CBORD has been trying to solve the diverse problems for customers. Here are some examples.

1. The campus has multiple systems that don't communicate with each other or share data.
   - Campus-wide connects to current system and legacy systems using interfaces offered by odyssey PCS

2. The campuses are over several locations.
   - Using WAN and LAN technologies, the Odyssey system can communicate with several different locations

3. The campus wants to use a student ID for multiple functions
   - Odyssey PCS can handle vending, laundry, copying, bookstore, library, recreation, voting, and dining halls. The software is designed to interface with several different companies' products.

4. The students are hard on their ID cards.
   - With CBORD, replacing lost cards is a snap!
   - Integrated Video Imaging System allows staff to make new cards on the fly, cancel old cards, and transfer privledges
   - The support group can provide with several products for keychains, lariats, and other card holders which serve to store and protect the cards from daily abuses

5. Parents and students want to track spending.
   - Whether they need a simple balance today or detailed information on all spending Odyssey PCS can provide it. Odyssey PCS can also give details for a certain time period, date, or location. Odyssey PCS also allows students and parents to add value to a card on the fly.

3.3 Smart Card System

A smart card is a plastic card embedded with a computer chip that stores and transacts data between users. This data is associated with either value or information or both and is stored and processed within the card's chip, either a memory or microprocessor. The card data is transacted via a reader that is part of a computing system. Smart card-enhanced systems are in use today throughout several key applications, including healthcare, banking, entertainment and transportation. To various degrees, all applications can benefit from the added features and security that smart cards provide. According to Dataquest, the worldwide smart card market will grow to 4.7 Billion units and $6.8 Billion by 2002.[4]

Comparing with the traditional 125 bytes magnetic stripe card, smart card provides larger storage capacity ranging from 1K bytes to 64K bytes. It comprises of a microprocessor (CPU), ROM, RAM, EEPROM and a serial communication interface. The built-in smartness enables smart card to protect information stored in it from unauthorized access.

In general, smart cards can be categorized into 5 different types according to their physical characteristics, namely Memory card, Contact card, Contactless card, Hybrid card and Combi card. Except memory card, the others are capable of processing data. Contact card is the most commonly used smart card among the four. It can be easily distinguished by the sharp gold plate chip on the card. As for contactless card, the chip is

[4] See Smart Card Basics and Security Overview, http://www.smartcardbasics.com/overview.html

embedded inside the card. Hybrid and combi cards are combined contact-contactless smart cards.

Smart Card has been applied to many business cases. The followings are several examples:[5]

- Banking and Loyalty

In the increasingly competitive and fast-changing business of banking and finance services, banks are seeking to bring new value-added services to their customers such as cash bonus point. Smart card technology offers enormous opportunities through its ability to deploy and manage multiple applications on a wallet-sized plastic card. The smart card also promises to resolve security issues through increasingly sophisticated methods of protection against theft and fraud.

- Telecommunication

Telecommunication sector is one of the largest markets for smart card applications. Payphone card and stored-value card were the earliest smart card application and they are still occupying the largest share of smart card market. In GSM/PCS mobile phones, SIM cards carry the subscriber's information and are used to authenticate user at each call. There are some value-added services such as mobile banking, information on-demand which are made available using large size smart cards.

- Transportation

Contactless smart card has been proven to be the most effective means for handling mass transactions.

[5] Based on Digital 21, Information Technology and Broadcasting Bureau of the Hong Kong Special Administrative Region Government, http://www.info.gov.hk/digital21/eng/knowledge/smart.html

- Healthcare

As smart cards are portable and capable of protecting confidential data across electronic networks, they are ideal for storing medical records, personal contact information and emergency medical data. On a trial basis, the Hospital Authority has adopted smart card for her Patient Card.

- Electronic Payment

As smart card is portable, tamper-resistant and capable of processing data, it is a suitable device for holding digital cash. Mondex and VisaCash are two examples of electronic purses used.

- Physical Access Control

Smart cards can be personalized to control access to restricted facilities, depending on user privileges and time restrictions. For example, campus identity card of universities and residential card is adopted in some private estates.

The smart card system has also been adopted for organizational purposes. The organizations responsible for adoption were driven by government mandate or monopolistic service providers because the complete system, comprising, front end devices (such as Card readers, Cash re-loaders and Card dispensers) and back end infrastructure (such as servers, software applications, networks, etc.) required a huge investment to be put in place. Only giant organizations can implement such large scale programs.

Unlike Europe, where governments or monopolies drove the adoption, there are alliances being formed to promote adoption of smart cards in the US, motivated by the profit potential the new technology can offer:[6]

Area	Organizations
Banking	VISA /MasterCard /AMEX/Smart Cash
Campus	Florida State University (Card applications Technology center), Battelle/Sallie Mae consortium, University of Michigan, NACCU
Pay TV	Thompson's RCA/ DSS, Sony /DSS, Hughes(Satellite), DirecTv & Prime Star (programming)
ID	Government (State and Central) agencies

There are several vendors and products in accordance with them. The following case describes Mac-Gray in further detail:

About Mac-Gray

One of Smart Card service vendors is Mac-Gray (http://www.mac-gray.com). The company provides Smart Card technology, compact refrigerators, commercial laundry equipment and vended copiers. They offer a full range of popular amenities in academic institutions, assisted living communities, Laundromats, the military, hotels and motels, apartment buildings and condominiums.

The company provides campus ID card, laundry machine, copier, microfridge, and door access reader. One of the big differences of using smart card instead of magnetic-strip card is banking and pre-paid value feature.

[6] See NEC Smart Card Report, http://home.att.net/~s-prasad/nec_exsum.pdf

Figure 3. Mac-Gray Solutions
(Source: Mac-Gray.com)

Multi-Functional smart ID card can give customers many benefits for many purposes. Let's consider the benefits of Smart Card. The following list is not intended to be all-inclusive but simply provides a cross-section of the types of benefits to be obtained with the implementation of multifunctional cards.[7]

- Identification

The Smart Card can contain a photo and/or a PIN (personal identification number) and can replace all existing identity cards for students, faculty and staff.

- Personal Security

The declining balance aspects of the card provide a number of benefits for the University community including reducing the need to carry cash. The card and/or P.I.N. could also be utilized to control access to various areas on campus such as residences, restricted labs, offices, etc.

- Reduced Costs for Delivery of Services

This can be realized by providing a common centralized approach to managing identification, declining balance and prepaid activities on campus. A common declining balance facility would simplify the charging process, reduce the banking effort, record

[7] Based on Campus ID Project Proposal, University of Waterloo, http://ist.uwaterloo.ca/sy/projects/idauth/id1993.html

keeping and eliminate the many refund processes. A very simple example of how this could work is the registration process. The receipt of fees by the University could automatically provide each student card holder with student account access, library access, prepaid meal plans, online access to other information, parking lot and residence access, etc.

- Increased Revenue

University can increase revenue through interest earned on moneys on deposit, partnerships with external service providers such as phone companies, allowing use of declining balance for purchases with local merchants, increased on-campus services and sales. Duke University, for example, has a total of $13M on deposit yearly for pre- paid card holders. At Clemson University, their ancillary operations have all experienced sales increases of between 15% and 40%.

Of course, some issues about introduction of Smart Card have been known for a while. Those issues include:

- Funding Sources

According to John Papinchak, Director of Enrollment Services, given the current financial situation of the University, the new ID system including hardware and software alternatives may not be feasible in the short term. Due to the recent economic slowdown, funding became really tight.

Most Universities that have introduced smart-cards have done so in conjunction with a sponsor, normally a Bank. There are good business reasons why this is the preferred option. It is estimated that the cost of a self-funded system is between $1.5-3 million to establish with high maintenance costs.[8]

[8] See Report on Smart Card Workshop, Aston University, http://www.sbu.ac.uk/litc/lt/1999/news1540.html

- Short Term Opportunities

A number of short term opportunities should be investigated as this project progresses. This may include re-evaluation of some of our business practices (departmentally as well as institutionally) in order to improve services or reduce costs, as well as investigating better ways to provide identification and privilege management capabilities while the ID project is being completed. These discussions and any decisions made to address short term opportunities will require strong management commitment and support at all levels.

- Security Issues

Smart cards provide computing and business systems the enormous benefit of portable and secure storage of data and value. At the same time, the integration of smart cards into your system introduces its own security management issues, as people access card data far and wide in a variety of applications. The followings are two major techniques to enhance security of Smart Card.[9]

- Public Key Infrastructure (PKI)

PKI provides a management framework for enabling public key cryptography deployment. A key pairs (Public and Private Key) and a digital certificate are the main components of the PKI. Private key and digital certificate are kept by individual as their personal identity whereas public key is made available to all users. Smart Card is a suitable medium for storing private key and digital certificates because of its security features. Data is encrypted when transmitting between the reader and the card. A dedicated processor is responsible for the encryption and decryption process. As such, the risk of exposure of private key carried by a smart card is low.

[9] Based on Digital 21, Information Technology and Broadcasting Bureau of the Hong Kong Special Administrative Region Government, http://www.info.gov.hk/digital21/eng/knowledge/smart.html

- PhotoBiometric Technology

In order to enhance the security of smart card authentication, biometric identification techniques are used to replace the conventional PIN method. While PIN is just a series of digits which cannot truly represent the personal identity, biometric identification techniques such as fingerprint and iris pattern identification can fill this gap. Recently some banks in Britain and Japan have started to use iris pattern to authenticate users on ATM machines. In the near future, biometric identification will be integrated in the smart card operating systems and users can use a combined PIN and biometric authentication scheme.

- Card Management Issues

One of problems that prevent the introduction of new system is lost cards. More than 1,000 cards are lost and this number is about 10% of total card holders. Smart Card is more expensive than magnetic-strip card and loss of ID card makes serious security problems.

- Real Benefit of Using Smart Card

Smart Card actually has plenty of benefits by providing multiple functions. However, there are also plenty of alternatives or substitutions such as debit or credit card. Therefore, University should investigate the expected usage of its new functions. If users do not feel more convenient than previous ID cards than the Smart Card system is waste of time and money. The following is the case of failure of introduction of Smart Card.10

[10] See "Smart card system for student IDs to end", Gerry Everding, http://record.wustl.edu/archive/1999/02-25-99/articles/smartcard.html

Failure Case: Washington University

Washington University ended its five-year trial of a system that allowed students to make on-campus purchases using computer chip-imbedded identification cards, when its contract with an outside supplier of the smart card technology expires, the administration has announced.

The new program did not develop quite as rapidly or as extensively as they would have liked. Students said it needed to be more convenient for them to get money onto the cards. University wanted a system that would allow them to transfer money from a bank account to a cash card, but that didn't happen. University also planned to have guest cards for use by off-campus visitors, but that didn't happen either.

The smart cards, which work like debit cards, allow students to transfer money into one of two computer-chip cash accounts; a "small change" account for vending machine purchases and a "SecureCash" account protected by a personal identification number for larger purchases. Most students used the "small-change" accounts at least occasionally, but only about one-third of students ever used the "SecureCash" option to make larger purchases. Smart card usage in campus vending and copying machines was never as heavy as expected, and many students apparently found it easier to use personal credit cards for larger purchases.

5. Business Case: Vending Machines Hamburg Hall

According to Joshua Frederick the last system upgrade project had a budget of about $250,000. This included hardware upgrades, software upgrades and organizational changes in order to accommodate the new business requirements. It would go beyond the scope of this paper to provide a full upgrade proposal business case. We will limit our efforts to model one possible upgrade – extending the current system to vending machines with card readers in Hamburg Hall (please see appendix for spreadsheet analysis).

In order to obtain current quotes on hardware and software products we had contacted the vendors that were introduced above. It was not possible to collect any up-to-date quotations from the vendors, hence, the following business case is based on the assumption that prices are similar as in the last upgrade. Given the short period of time since the last upgrade, this seems to be a reasonable assumption. The supplier market structure did not change since then and no remarkable product innovations have occurred.

An extension of CampusXpress to vending machines would go hand in hand with an upgrade for laundry machines and copier machines. It seems obvious to choose a vending network as a business case to model further planning and calculations in other areas. Hamburg Hall provided an excellent example as we were familiar with the building, the number of machines, the number of rooms and the number of customers in the building.

We estimated the number of students in the building at 800. Faculty and staff have their own food area and kitchen. Therefore, we assumed that their consumption was negligible in comparison to the students'. The hardware costs are split up between the vendors and the university. The vendors are responsible for purchasing any reader equipment and paying for the maintenance on the hardware up-front. CMU is responsible for obtaining the server software and for wiring each single room. As the server software will be shared across the university departments the cost were split.

Each cluster of vending machines or laundry machines requires a multiplexer as a room controller which ultimately lowers the cost of each single reader to be installed. Clusters in this particular form do not exist in Hamburg Hall, hence, we calculated the full wiring and hardware cost per room and reader.

Increasing the usability of the vending machines will lead to an increase in sales. We conservatively estimated the increase at 15%. Given the estimated current sales this would lead to an additional turnover of nearly $25,000 for the vendor and an additional $4,000 in profits per year. The NVP analysis for a 5-year investment period shows an excellent $12,335 for this investment. Out of a vendor's point of view upgrading the vending machines is an excellent business opportunity with high pay-offs.

CMU's revenue streams are based upon either flat rates or discount rates charged to their customers based upon the contract that the vendors negotiate. According to Joshua Frederick, the range on the discount rate is 2 - 8 percent. CMU does not intend to make profit from its investments in this area. It simply wants to break even and additionally build up a reserve for future capital improvements to the system. CMU's additional profit from its investment is the marginal increase in commission charged to the vendors. We simplified the complex negotiation structure in assuming an average commission rate of 5% on all transactions. Given the cost and the additional revenue this leads to a negative NPV of $6,230. The NPV does not turn positive unless the increase in sales goes up to 35% which does not seem reasonable.

Additionally to the monetary aspects of the investment CMU also has to consider satisfaction of students, higher security by carrying less cash etc. Taking this into consideration the investment might still have an overall positive pay-off for the university. Furthermore, as the investment turned out to be that profitable for the vendor, CMU might be able renegotiate parts of the cost split with the vendors. This would lower its cost and could ultimately lead to a break even.

6. Summary

The purpose of this paper is to give an overview of the CampusXpress system at Carnegie Mellon University. A detailed description of the hardware components, network components and organizational aspects of the system provides a clear picture of the capabilities as well as the limitations of the present system. Additionally, this paper introduces three possible extension and upgrade technologies currently available on the market. We did not only describe the technological details of these solutions but also tried to sketch out the business implications that come with them. Finally, a business case for an extension of the current CampusXpress system to Hamburg Hall's vending machines is presented. The findings indicate that this investment would be very profitable to the vendor. Despite the negative NPV for CMU there is still a chance that the university considers this investment as acceptable if further improvements in the service level and the security of students can be identified.

We see the scope of this paper to be limited to a preliminary analysis of the extension opportunities of the current system. We predict that either CBoard or Blackboard will offer the most feasible solutions for upgrading. Given the negative experiences with Smart Card solutions at other universities, this solution does not yet seem mature enough. For further steps we suggest to receive detailed price information from the listed vendors. Additionally, the model business case should be applied to all campus locations and all business areas, including copier machines and laundry machines.

7. Appendix

Hardware		**Business Facts**	
Wiring cost per room	$ 1,000.00	Number of people	800
Reader cost	$ 500.00	Margin beverages	20%
Server Software	$ 5,000.00	Margin snacks	30%
Upgrade cost/machine	$ 100.00	Margin CMU	5%
Vending machines	10	Business impact	15%
Rooms	7	Cost of Capital	15%
Maintenance Lump Sum	$ 2,000.00	Labor Savings	50%

at 35% the investments pays off for CMU

Business Case Vendor

COST

Readers	$ 5,000.00
Upgrade Cost	$ 1,000.00
Maintenance lump sum	$ 2,000.00
Total	*$ 8,000.00*

RETURN

			Winter/Fall	Summer (50%)		Total	Margin	Net Profit
Hot beverages/day	$	520.00	150	37.5	$	97,500.00	15.00%	$ 14,625.00
Beverages/day	$	266.67	150	37.5	$	50,000.00	15.00%	$ 7,500.00
Snacks/day	$	93.33	150	37.5	$	17,500.00	25.00%	$ 4,375.00
Total per day	*$*	*880.00*	*Total turnover*		*$*	*165,000.00*		*$26,500.00*
			Total Increased turnover		$	189,750.00		$ 30,475.00
			Additional Return		***$***	***24,750.00***		***$ 3,975.00***

Labor Savings	Hours/week	Weeks/year		Cost/Hour	Total Cost	Change
	2	52	$	25.00	$ 2,600.00	50%
	Additional Savings					***$ 1,300.00***

NPV Analysis

Time (years)	**1**	**2**	**3**	**4**	**5**
Cost	$ 8,000.00				
Profit	$ 5,275.00	$ 4,586.96	$ 3,988.66	$ 3,468.40	$3,016.00
NPV of Investment	***$ 12,335.01***				

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Business Case Carnegie Mellon University

COST		**RETURN**							
				Winter/Fall	Summer (50%)		Total	Margin	Net Profit
Rooms	$ 10,000.00	Hot beverages/day	$ 520.00	150	37.5	$	97,500.00	5.00%	$ 4,875.00
Software	$ 1,000.00	Beverages/day	$ 266.67	150	37.5	$	50,000.00	5.00%	$ 2,500.00
		Snacks/day	$ 93.33	150	37.5	$	17,500.00	5.00%	$ 875.00
Total	*$ 11,000.00*	*Total per day*	*$ 880.00*	*Total turnover*		*$*	*165,000.00*		*$ 8,250.00*
				Total Increased turnover		$	189,750.00		$ 9,487.50
				Marginal increase		**$**	**24,750.00**		**$ 1,237.50**

NPV Analysis

Time (years)	**1**	**2**	**3**	**4**	**5**
Cost	$ 11,000.00				
Profit	$ 1,237.50	$ 1,076.09	$ 935.73	$ 813.68	$ 707.54
NPV of Investment	***$ (6,229.46)***				

Clarifications:

Wiring cost, reader cost and server cost based on last upgrade with no rebates
Daily consumptions based on 800 persons in HBH and estimated consumption per person
Summer days are less busy than Winter and Fall (15 weeks per semester)
Margins are based on estimations of vendor margins minus average CMU commission (AVG(2 - 8%) = 5%)
CMU purchases the server software and the wiring, vendors purchase readers
Server Cost is split up equally between the 5 CMU Schools
Vendor's money collector spends 2h a week to collect the money in the base case, savings with the new system are 50%

Interviews:

Joshua Frederick
System Operator of Business Service Center, Carnegie Mellon University

John Papinchak
Director of Enrollment Services Carnegie Mellon University

Rosemary Lewis
Carnegie Mellon University HUB

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