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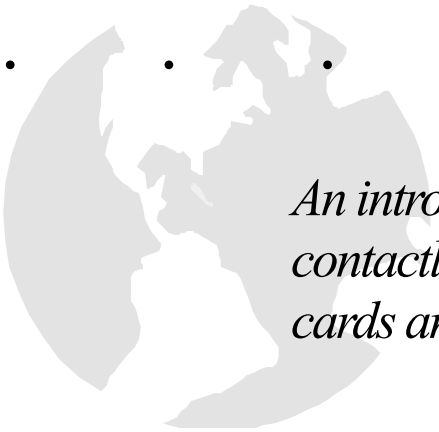
The Smart Card Evolution



An introduction to the benefits of contactless, microprocessor-based smart cards and devices

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The Origin of Smart Cards

The origin of smart cards began when consumer requirements for convenience and security outpaced the capabilities of magnetic stripe cards. Providing increased data storage and added security, smart cards were introduced in Europe in the early 1980's as stored value cards for payphones. These early smart cards were disposable, and were an effective means to reduce losses.

Today's smart cards are re-usable, hold large quantities of data, speed transaction times, identify the cardholder, and even provide loyalty benefits. And this is only the beginning of the age of smart cards.

Types of Smart Cards Today

While smart cards can be categorized using several different parameters, the two most feasible methods are by functional use (contact vs. contactless) and by chip hierarchy.

Contact vs. Contactless

Functional use (contact vs. contactless) refers to the means by which the smart card is able to transfer data to a smart card reader. In a *contact* scenario, the cardholder inserts the card into the slot of the contact reader. When inserted appropriately, the contact plate (visible metallic plate) of the smart card aligns with the electronic contacts inside the reader, and data is transmitted across this connection.

Contactless scenarios are those in which the smart card (or smart watch, smart key fob, etc.) transfers data with the reader without the two making contact. This transaction occurs when the cardholder presents the card within a close proximity (up to 15 cm) from the reader. The data is conveyed across this distance via electro-magnetic fields.

While the original smart cards were *contact* in nature, today's requirements of increased transaction speed and customer convenience are driving the market towards

contactless environments. In the *contact* scenario the cardholder must stop at the terminal, align the card with the reader slot, insert the card, perhaps press an "accept" button, and retract the card. Conversely, the *contactless* cardholder can often present the card to the reader while walking past it. For applications requiring high volumes, such as mass transit, this difference between *contact* and *contactless* is monumental. Even for applications in the other arenas, the contactless advantage could be the difference between a repeat customer, and one who seeks optimal service elsewhere.

Chip Hierarchy

The category of chip hierarchy refers to the method in which the chip (within the smart card) is constructed, and the resulting capabilities of that chip. And as with many technologies, the more simplistic the construction, the more limited the flexibility. In today's market, there are three primary categories in this chip hierarchy: *memory* chips, *application specific integrated circuits (ASICs)*, and *microprocessor* chips.

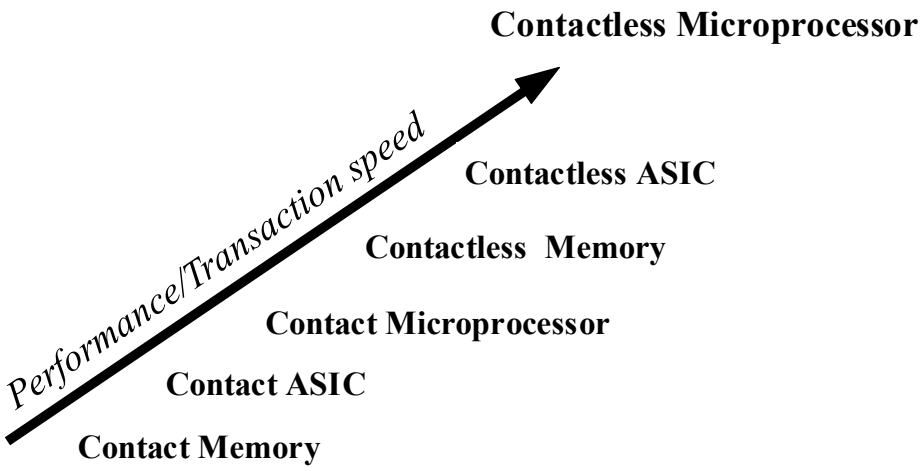
1. Memory chips, the most basic, are a simple data repository with no processing capabilities. The memory can only hold static data (ID#, Name, etc.), or a log of information not requiring dynamic encryption. Memory chips are unable to process any data, and cannot be reprogrammed once they have been created. To alter the capabilities of a memory card, the card would have to be completely replaced.

2. ASIC chips are hard-coded (constructed) to retain data and perform a particular processing task. This processing capability makes ASICs more powerful than memory chips. In addition to simple processing of data, this difference also provides for limited static encryption. (This static encryption is not accepted by financial institutions and usually only allowed on low security applications such as access control.) While the ASIC is more powerful than a memory chip, neither can be reprogrammed once created. Replacement is the only means to add/change chip capabilities for both memory and ASIC chips.

3. Microprocessor chips are the most complex and powerful of the three classes. These microprocessors function similarly to a computer, with an analogous level of software flexibility. Like the first two categories, microprocessor chips retain data. And similar to the ASICs, microprocessors have processing capabilities. The distinguishing factors of microprocessors are that their processing capabilities allow for dynamic encryption, and also for updating their software applications.

   This could mean either adding/subtracting applications, or improving the version of an existing application. These updates can be easily downloaded to the microprocessor at the merchant terminal, special download kiosks, or via the Internet. In today's environment of constantly improving software, and of combining multiple applications on one card, this capability of microprocessors can make the difference in a successful smart card program.

Evolution of Smart Cards, illustration 1



Building Successful Smart Card Programs

With approximately two decades of smart card projects around the globe, the smart card community has learned much about creating a successful program. While *closed-campus* implementations (employees within a business, residents within one building, etc.) have the advantage of being able to require smart card use, implementations open to the public need to prove their value if they are to succeed. These *open* implementations require comprehensive planning and forethought to ensure public acceptance.

While today's technology-savvy public expects that new products function 100 percent of the time at 100 percent accuracy, fulfilling this requirement will not be sufficient to guarantee success of the project in the long term. Ensuring long-term success for smart card programs requires providing: relevant consumer benefits, multi-application capacity, and on-going operational ease.

Balance consumer effort with consumer benefit

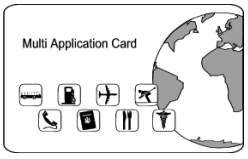
The public demands that smart cards, like any new product, bring obvious benefit to the existing process. Regardless of the benefits to the proprietor, (accuracy, cost savings, etc.) successful smart card programs must provide benefits to the consumer greater than the consumer-perceived effort in adapting the smart card behavior. The more challenging it is to understand and use the card, the greater the benefit must be.

For example, consider the replacement of coins with smart cards in making small retail purchases. The public will accept this substitution only if smart card use derives a perceived benefit. It is not enough that the proprietor's cash-handling cost is decreased. The consumer makes the final decision. Is the smart card transaction faster for the consumer than that with coins? Is the smart card transaction more convenient? Does it provide a discount or loyalty points? If there is no perceived benefit, the public's long-term acceptance of this new behavior is dubious.

Multi-application programs show greatest potential

Consumers feel they carry too many cards as it is. Several credit cards, debit cards, a driver's license, and membership cards all currently fight for space in the consumer's wallet. (This is often referred to as competing for "share of wallet".) Asking the consumer to carry another card for each proprietary smart card program goes against the consumer's inherent desire for consolidation and convenience. All other parameters being equal, consumers prefer carrying one smart card that can be used at multiple environments to carrying multiple cards, each with exclusive functionality at one environment.

For example, consumers prefer carrying one card that provides: building/office access, purchase capabilities at multiple stores, and loyalty rewards. These *multi-application* smart cards are especially attractive to consumers being offered a second smart card. And as additional smart card programs are launched, and competition for "share of wallet" increases, providing consumers with multi-application functionality is a primary means of ensuring the success of a particular smart card.



In addition, the industry is now openly acknowledging and accepting that there are no static solutions in the smart card world. Success requires the capability to update applications (and add new applications) to existing cards. Whether the primary focus of the card is access control or e-purse, the capability for the cards to be updated is imperative in the long term.

Total solution cost vs. Up-front cost

A common error during smart card implementations is to focus entirely on the launch date and launch costs. While the launch is important to the program's success, the on-going operations are even more imperative. The on-going operations' impact is so great because it is these efforts and costs that accumulate over time. How much effort will be required for the maintenance of readers, cards, and software? What about the durability of equipment, and environmental impacts on hardware kept outdoors? These factors all greatly impact the long-term success of a program.

The most common form of this error is to exclusively consider the up-front purchase prices of readers and cards. Purchasing inexpensive readers or cards that later require frequent replacement defeats the initial economic objective. For instance, utilizing a *contact* smart card system in a high usage environment may appear attractive due to the lower initial costs of contact readers. However, once launched, the high traffic expedites the natural wear on the contact plates within the device. The result is that the cost savings of paying a lower purchase price are quickly reversed by having to frequently replace the readers. The preliminary cost savings becomes an expense in perpetuity. (And the occurrence of vandalism to *contact* readers only aggravates the negative economics of this scenario.)

Benefits of Contactless, Microprocessor-based Smart Cards

Benefits of being Contactless:

- **Speed**: Contactless transactions provide a much faster total transaction time for consumers.
- **Convenience**: Contactless transactions require less effort for the consumer – just present the card and go.
- **Low maintenance**: Without components exposed to the elements and to the friction of contact scenarios, contactless systems require less maintenance.
- **Consumer appeal**: Contactless systems can employ a large array of form factors in addition to cards – watches, key fobs, rings, etc. Consumer appeal can be optimized depending on the application and the target market.

Benefits of being Microprocessor-based:

- **Secure**: Microprocessor-based cards can comply with the highest protocols of security – DES, RSA, and ECC.
- **Synergies of Multi-application**: Microprocessors have the capacity to handle multiple applications on the same card. The consumer gets the benefits of two or more services in one product.
- **Easy-to-update**: The computing power of a microprocessor provides for updating the cards even after the launch. Whether adding a new application, or updating an existing one, consumers can update their cards on the fly.

When planning a smart card implementation, an objective long-term business analysis quickly demonstrates the multiple benefits of a contactless, microprocessor-based system. Comparing the total solution costs of the alternative systems consistently demonstrates the favorable return on investment of contactless, microprocessor-based smart cards.

Summary

Smart cards have evolved in the past two decades from plastic cards with simple contact-based memory chips to the ultimate flexibility of contactless microprocessors in a wide array of smart objects. But technological advances alone will not ensure the long-term success of smart cards. From the consumer perspective, the benefits of adopting this new technology must greatly outweigh the effort required to alter long-standing habits. With the strength, flexibility, and capacity of contactless microprocessors, card issuers have access to a powerful tool to win consumer smart card acceptance and, in the process, enhance customer relationships.

For more information

For additional information on our products and technologies, check out our Web site at www.otiamerica.com, or contact us at:

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