Smart Cards in Wireless Services

Definition
This tutorial presents a business case for the use of smart cards or subscriber identity modules (SIMs) in the marketing and network operations of wireless communications operators. The business case focuses on the SIM card’s marketing, financial, and technical benefits to network operators as well as benefits to wireless consumers. Some key external factors likely to accelerate customer acceptance are also discussed.

Overview
Today, the SIM card’s basic functionality in wireless communications is subscriber authentication and roaming. Although such features may be achieved via a centralized intelligent network (IN) solution or a smarter handset, there are several key benefits that could not be realized without the use of a SIM card, which is external to a mobile handset. These benefits—enhanced security, improved logistics, and new marketing opportunities—are key factors for effectively differentiating wireless service offerings. This tutorial assumes a basic knowledge of the wireless communications industry and will discuss the security benefits, logistical issues, marketing opportunities, and customer benefits associated with smart cards.

Topics
1. Smart Card Overview
2. Introduction to Smart Cards in Wireless Communications
3. Enhanced Security Benefits
4. Easing Logistical Issues
5. Providing Value-Added Services
6. Marketing Opportunities
7. Customer Benefits
8. Factors Driving Smart-Card Acceptance
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1. Smart Card Overview

The smart card is one of the latest additions to the world of information technology (IT). The size of a credit card, it has an embedded silicon chip that enables it to store data and communicate via a reader with a workstation or network. The chip also contains advanced security features that protect the card’s data.

Smart cards come in two varieties: microprocessor and memory. Memory cards simply store data and can be viewed as a small floppy disk with optional security. Memory cards depend on the security of a card reader for their processing. A microprocessor card can add, delete, and manipulate information in its memory on the card. It is like a miniature computer with an input and output port, operating system, and hard disk with built-in security features.

Smart cards have two different types of interfaces. Contact smart cards must be inserted into a smart-card reader. The reader makes contact with the card module’s electrical connectors that transfer data to and from the chip. Contactless smart cards are passed near a reader with an antenna to carry out a transaction. They have an electronic microchip and an antenna embedded inside the card, which allow it to communicate without a physical contact. Contactless cards are an ideal solution when transactions must be processed quickly, as in mass transit or toll collection.

A third category now emerging is a dual interface card. It features a single chip that enables a contact and contactless interface with a high level of security.

Two characteristics make smart cards especially well suited for applications in which security-sensitive or personal data is involved. First, because a smart card contains both the data and the means to process it, information can be processed to and from a network without divulging the card’s data. Secondly, because smart cards are portable, users can carry data with them on the smart card rather than entrusting that information on network storage or a backend server where the information could be sold or accessed by unknown persons (see Figure 1).
A smart card can restrict the use of information to an authorized person with a password. However, if this information is to be transmitted by radio frequency or telephone lines, additional protection is necessary. One form of protection is ciphering (scrambling data). Some smart cards are capable of ciphering and deciphering, so the stored information can be transmitted without compromising confidentiality. Smart cards can cipher into billions of foreign languages and choose a different language at random every time they communicate. This process ensures that only authenticated cards and computers are used and makes hacking or eavesdropping virtually impossible.

The top five applications for smart cards throughout the world currently are as follows:

- **public telephony**—prepaid phone memory cards using contact technology
- **mobile telephony**—mobile phone terminals featuring subscriber identification and directory services
- **banking**—debit/credit payment cards and electronic purse
- **loyalty**—storage of loyalty points in retail and gas industries
- **pay-TV**—access key to TV broadcast services through a digital set-top box

The benefits of using smart cards depend on the application. In general, applications supported by smart cards benefit consumers where their lifestyles intersect with information access and payment-related processing technologies. These benefits include the ability to manage or control expenditures more
effectively, reduce fraud and paperwork, and eliminate the need to complete redundant, time-consuming forms. The smart card also provides the convenience of having one card with the ability to access multiple services, networks, and the Internet.

2. Introduction to Smart Cards in Wireless Communications

Smart cards provide secure user authentication, secure roaming, and a platform for value-added services in wireless communications. Presently, smart cards are used mainly in the Global System for Mobile Communications (GSM) standard in the form of a SIM card. GSM is an established standard first developed in Europe. In 1998, the GSM Association announced that there are now more than 100 million GSM subscribers. In the last few years, GSM has made significant inroads into the wireless markets of the Americas.

Initially, the SIM was specified as a part of the GSM standard to secure access to the mobile network and store basic network information. As the years have passed, the role of the SIM card has become increasingly important in the wireless service chain. Today, SIM cards can be used to customize mobile phones regardless of the standard (GSM, personal communications service [PCS], satellite, digital cellular system [DCS], etc.).

Today, the SIM is the major component of the wireless market, paving the way to value-added services. SIM cards now offer new menus, prerecorded numbers for speed dialing, and the ability to send presorted short messages to query a database or secure transactions. The cards also enable greeting messages and company logotypes to be displayed.

Other wireless communications technologies rely on smart cards for their operations. Satellite communications networks (Iridium and Globalstar) are chief examples. Eventually, new networks will have a common smart object and a universal identification module (UIM), performing functions similar to SIM cards.

3. Enhanced Security Benefits

SIM cards have several features that enhance security for wireless communications networks. Smart-card supporters point to the potential of limiting or eliminating fraud as one of their strongest selling points.

SIM cards provide a secure authentication key transport container from the carrier’s authentication center to the end-user’s terminal. Their superior fraud protection is enabled by hosting the cryptographic authentication algorithm and
data on the card’s microprocessor chip. SIM cards can be personal identification number (PIN) protected and include additional protection against logical attacks. With added PIN code security, SIM cards offer the same level of security used by banks for securing off-line payments.

Because the home network–authentication algorithm also resides in the card, SIM cards make secure roaming possible. They can also include various authentication mechanisms for internetwork roaming of different types.

Complete fraud protection (with the exclusion of subscription fraud) can only be provided in the context of a complete security framework that includes terminal authentication, an authentication center, and authentication key management. Smart cards are an essential piece of this environment, but only the complete architecture can allow fraud reduction and secure roaming.

Finally, it should be noted that biometric smart-card applications such as voice or fingerprint recognition could be added to provide maximum fraud prevention. Smart cards could then combine the three basic security blocks of possession, knowledge, and characteristics (see Figure 2).

![Figure 2. Identification Model](image.png)

Source: 1994 Advanced Card and Identification Technology Sourcebook

### 4. Easing Logistical Issues

All subscribers may easily personalize and depersonalize their mobile phone by simply inserting or removing their smart cards. The card’s functions are automatically enabled by the electronic data interchange (EDI) links already set between carriers and secure personalization centers. No sophisticated programming of the handset is necessary.

By placing subscription information on a SIM card, as opposed to a mobile handset, it becomes easier to create a global market and a distribution network of
phones. These noncarrier-specific phones can increase the diversity, number, and competition in the distribution channel, which can ultimately help lower the cost of customer acquisition.

Smart cards make it easier for households and companies to increase the number of subscriptions, thereby increasing usage. They also help to create a market for ready-to-use preowned handsets that require no programming before use.

Additionally, managing fraud is also eased by smart cards. In a handset-centric system, if a phone is cloned, the customer must go to a service center to have the handset reprogrammed or a new phone must be issued to the customer. In a smart card–based system, the situation can be handled by merely issuing a new card—the customer can continue using his or her current phone. The savings in terms of cost and convenience to both carrier and customer can be substantial.

5. Providing Value-Added Services

One of the most compelling benefits of smart cards is the potential for packaging and bundling various complementary services around basic mobile telephony services. These services can greatly reduce churn and increase usage and brand recognition (see Figure 3).

![Figure 3. Service Bundling with Smart Cards](image)

The SIM card’s chip can be programmed to carry multiple applications. The activation of new applications can be downloaded to the card over the air, in real time, thereby reducing the time (and cost) to market.

Providing value-added services such as mobile banking, Web browsing, or travel services creates a high cost of exit for the customer. Long-distance companies have successfully used joint programs with airline companies to ensure the long-
term loyalty of their customers. The more services a customer receives, the more difficult it is for the customer to leave the service provider. Smart cards provide an excellent vehicle for surrounding the core wireless service with these other valuable services, and packaging- and service-bundling opportunities are numerous. Examples of such opportunities are as follows:

- GSM Cellnet and Barclaycard, Europe’s largest credit-card issuer, developed a wireless, financial-services smart card. The SIM card activates the user’s Cellnet GSM phone and also provides a Barclays services menu. The services available via this alliance include the following:
  - access to Barclays credit-card information
  - access to Barclays checking-account information
  - access to Barclays customer care

- Initially, the Barclaycard services will be provided via live customer service representatives who will answer calls from customers. Future enhancements will enable users to pay household bills, shop, and access financial information services while on the move.

- Swedish bank PostGirot implemented a utility bill−payment application in the Telia Mobitel SIM card. Mobile phone users accessed the service by simple menu navigation and keying information such as origin and destination bank-account numbers, date of payment, and amount, which enables them to pay their utility bills away from home.

### 6. Marketing Opportunities

In addition to the value-added services they can provide, smart cards provide many marketing opportunities to network operators.

**Brand Recognition**

Smart cards provide a means for greater brand exposure and reinforcement. The cards can be considered mini-billboards, providing frequent opportunities for the customer to be exposed to a brand name. Compared to other advertising media, they provide a cost-effective vehicle for achieving a high number of brand exposures to a targeted audience. Network operators with limited brand recognition can co-brand their cards with companies with greater brand equity to strengthen their market positions.
Customer Loyalty Programs

Smart cards can play an extremely valuable role in a carrier’s customer retention efforts. The data on a smart card is a digital representation of the customer’s habits; i.e., number of calls, services accessed, merchandise purchases, etc. This rich database of customer information makes it possible for network operators to develop highly targeted or one-to-one marketing. Carriers are then able to provide services and offerings particularly suited to their customers, increasing customer loyalty to the carrier.

Direct Marketing

With their convenient form factor, smart cards can be used in direct-mail campaigns to sell wireless subscriptions, both for prospecting and subscription renewal. Using temporary or prepaid smart cards, network operators have a low-cost channel for selling their services. In addition, subscription changes, renewals, and upgrades are easily handled by sending new cards in the mail (see Figure 4).

Figure 4. A Direct Marketing Scenario

Advertising

Two services, used in conjunction with smart cards, provide network operators with possibilities for highly targeted advertising. Short message service (SMS)
and cell broadcast leverage smart cards to send advertising or informational messages that appear on the handset display to wireless users.

**Trial Subscriptions**

Smart cards are an ideal vehicle for trial subscriptions. Programmed as prepaid cards, they can attract new customers to try wireless services with limited, defined financial risk for both the network operator and the consumer.

**Incidental Revenues**

Network operators issuing smart cards can generate additional revenue by selling memory space on the card to other companies. For example, available space can be sold to gas stations so that the smart card can also be used as a debit card for gas purchases. The card’s surface can also be used for imprinting the participating company’s brand, for which the carrier can receive fees for space advertising.

**7. Customer Benefits**

**Full Portability of Services**

The smart card effectively breaks the link between the subscriber and the terminal, allowing the use of any properly equipped terminal and helping to realize the wireless promise of anytime, anywhere communications. In fact, subscribers need not be constrained to using voice terminals only. A variety of other mobile communications devices such as personal digital assistants (PDAs) and personal intelligent communicators (PICs) are available that may have voice communications added as an integral part of their capabilities. If these other devices are equipped for smart cards, the potential for communications is increased. Similarly, data communications applications could benefit from the security features inherent in smart cards.

**International Roaming**

Wireless customers often require the ability to place and receive calls when traveling abroad. For these customers, international roaming enabled by smart cards is quite valuable. For example, Ameritech, AT&T, and GTE have all instituted international roaming programs using GSM phones and smart cards. The program uses co-branded smart cards, which corporate customers bring with them when they travel abroad. Customers are given a telephone number from a
GSM carrier, which allows them to be contacted in any of the countries that have international roaming agreements.

**Intersystem Roaming**

The incompatibility of different communications radio interfaces and authentication protocols (time division multiple access [TDMA], code division multiple access [CDMA], GSM, personal digital cellular [PDC], mobile satellite systems, etc.) requires subscribers to make choices that constrain them to use only one particular type of handset that works with only one radio interface. With a smart card, it becomes possible for subscribers to use one handset for different interfaces and protocols. This feature is already implemented among the three frequencies used by the GSM platform (900, 1800, and 1900 MHz). American National Standards Institute (ANSI) telephone industry price index (T1P1).3 has recommended standards for a user identity module, a smart card that can be used with the major radio access methods. Thus, it becomes conceivable to have current GSM smart cards modified so that they can work with a CDMA handset. For example, North American GSM operators have designed a process in which the SIM holds both the GSM and advanced mobile phone service (AMPS) authentication algorithm and data to provide authentication on both networks in interroaming situations.

**Multiple Services on a Single Card**

As mentioned earlier, maximum value is realized by the subscriber when multiple applications are stored on a single card (see Figure 5). A multiapplication smart card could provide access to airline reservation and ticketing systems and information networks, as well as a mobile telephone service. Considering the many cards that the average person carries these days (i.e., numerous credit cards, debit cards, employee ID cards), integrating more applications into a single card (or at least fewer cards) has obvious appeal and benefits. It is important to note that there is clear interest on the part other industries to package their services with mobile telephony. For example, research by Citibank indicates clearly that a substantial percentage of the company’s customers would like to be able to conduct its banking on a variety of platforms, including wireless. Such services are already available using a standardized toolbox for smart-card application creation.
Separation of Business and Personal Calls

The smart card allows customers to be billed separately for personal and business calls made on a single phone. For example, Airtel, a Spanish GSM operator, uses a SIM card with two sets of subscription information—one for corporate and the other for personal use. Airtel’s dual SIM cards have been well received in the corporate market.

8. Factors Driving Smart-Card Acceptance

Other Industries and Institutions

Certain industries, in particular information technology (IT), government, and financial services, will lead the way to mass-market acceptance of smart cards.

Large IT players are deploying public key infrastructure (PKI) to provide secure logical access to information. PKI is becoming the way to secure messaging and browsing of private information, leading the way to secure electronic commerce. Smart cards are the ideal vehicle to transport the digital certificate associated with the trusted third parties of PKI infrastructures. They provide secure certificate portability and can combine other security applications such as disk file encryption and secure computer log-on. The inclusion of smart-card readers in the equipment listed in the PC99 recommendation has already driven large computer manufacturers to integrate smart-card readers into their product offer (for example, Hewlett Packard and Compaq).

Government agencies around the world are relying on smart-card technology to secure off-line portable information, including identification documents and
electronic benefit transfer systems. A Brazilian province has issued its drivers licenses on smart cards to allow the police to view securely stored ticket information immediately. The U.S. government is a major early adopter of smart cards. It has instituted numerous smart card identification programs for its defense department and recently announced that it will further explore the nationwide use of smart cards for electronic benefit transfers as a fraud reduction tool.

In the financial industry, large players such as Barclays and Citibank currently use SIM cards to provide banking information to mobile users via their GSM phones. Electronic purse systems based on VisaCash, Mondex, Proton, and other schemes are deployed around the world and account for tens of millions of cards in Asia, Europe, and Latin America. Major U.S. banks are considering or conducting trials of smart card-based systems. The push by these major financial services firms will serve to accelerate consumer acceptance.

**Consumers Primed to Use Smart Cards**

Research conducted by the Smart Card Forum, an interindustry association dedicated to advancing multiapplication smart cards, has generated the following statistics:

- 45 percent of consumers are favorably disposed to using smart cards
- 25 percent of households would actually obtain these smart cards
- 44 percent of consumers are likely to use identification-type smart cards (telephone cards, gas cards, automated teller machine [ATM] cards, etc.)

**Self-Test**

1. Enhanced security, improved logistics, and new marketing opportunities may be achieved via a centralized intelligent network solution or a smarter handset.
   a. true
   b. false

2. Which of the following is like a miniature computer with an input and output port, operating system, and hard disk with built-in security features?
   a. memory card
b. microprocessor card

3. _______________ smart cards are inserted into a smart-card reader.
   a. Contact
   b. Contactless

4. _______________ smart cards are passed near a reader with an antenna to carry out a transaction.
   a. Contact
   b. Contactless

5. The SIM is the primary component of the wireless market paving the way to value-added services.
   a. true
   b. false

6. Even with value-added PIN security, SIM cards cannot offer the same level of security used by banks for securing off-line payments.
   a. true
   b. false

7. Managing fraud is made easier with a handset-centric system.
   a. true
   b. false

8. The activation of new applications can be downloaded to the SIM card over the air.
   a. true
   b. false

9. Which of the following statements is not true of smart cards?
   a. Multiple applications can be stored on a single card.
   b. One handset may be used for different interfaces and protocols.
10. Network operators can sell memory space on a smart card to other companies.
   
   a. true
   
   b. false

**Correct Answers**

1. Enhanced security, improved logistics, and new marketing opportunities may be achieved via a centralized intelligent network solution or a smarter handset.
   
   a. true
   
   b. false
   
   See Overview.

2. Which of the following is like a miniature computer with an input and output port, operating system, and hard disk with built-in security features?
   
   a. memory card
   
   b. microprocessor card
   
   See Topic 1.

3. ______________ smart cards are inserted into a smart-card reader.
   
   a. Contact
   
   b. Contactless
   
   See Topic 1.

4. ______________ smart cards are passed near a reader with an antenna to carry out a transaction.
   
   a. Contact
   
   b. Contactless
See Topic 1.

5. The SIM is the primary component of the wireless market paving the way to value-added services.
   
   a. true
   
   b. false
   
   See Topic 2.

6. Even with value-added PIN security, SIM cards cannot offer the same level of security used by banks for securing off-line payments.
   
   a. true
   
   b. false
   
   See Topic 3.

7. Managing fraud is made easier with a handset-centric system.
   
   a. true
   
   b. false
   
   See Topic 4.

8. The activation of new applications can be downloaded to the SIM card over the air.
   
   a. true
   
   b. false
   
   See Topic 5.

9. Which of the following statements is not true of smart cards?
   
   a. Multiple applications can be stored on a single card.
   
   b. One handset may be used for different interfaces and protocols.
   
   c. Subscribers use voice terminals only.
   
   d. Customers can be billed separately for personal and business calls.
   
   See Topic 7.
10. Network operators can sell memory space on a smart card to other companies.

   a. true
   
   b. false
   
   See Topic 6.

**Glossary**

**AMPS**
advanced mobile phone service

**ANSI**
American National Standards Institute

**CDMA**
code division multiple access

**DCS**
digital cellular system

**EDI**
electronic data interchange

**GSM**
Global System for Mobile Communications

**IN**
intelligent network

**IT**
information technology

**PCS**
personal communications service

**PDA**
personal digital assistant

**PDC**
personal digital cellular

**PIC**
personal intelligent communicator
**PIN**
personal identification number

**PKI**
public key infrastructure

**SIM**
subscriber identity module

**SMS**
short message service

**TDMA**
time division multiple access

**TIPI**
telephone industry price index

**UIM**
universal identification module