Smart Cards Primer

By Charles Cagliostro

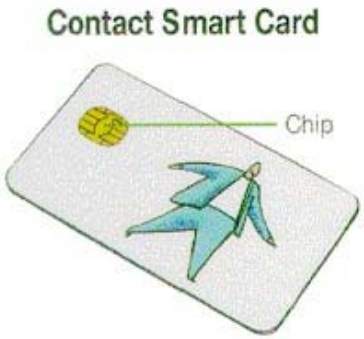
Defined at its highest level, a smart card is a credit-card sized plastic card with an embedded computer chip. The chip can either be a microprocessor with internal memory or a memory chip with non-programmable logic. The chip connection is either via direct physical contact or remotely via a contactless electromagnetic interface.

History

The technology has its historical origin in the seventies when inventors in Germany, Japan, and France filed the original patents. Due to several factors, not least of which was the immaturity of the semiconductor technology, most work on smart cards was at the research and development level until the mid eighties. Major rollouts such as the French National Visa Debit Card and France Telecom provided the industry with high volume opportunities. Since then, the industry has been growing at tremendous rate is shipping more than one billion (1,000,000,000) cards per year (since 1998).For an interesting historical perspective of the seventies and eighties, check out the card museum .

Technology

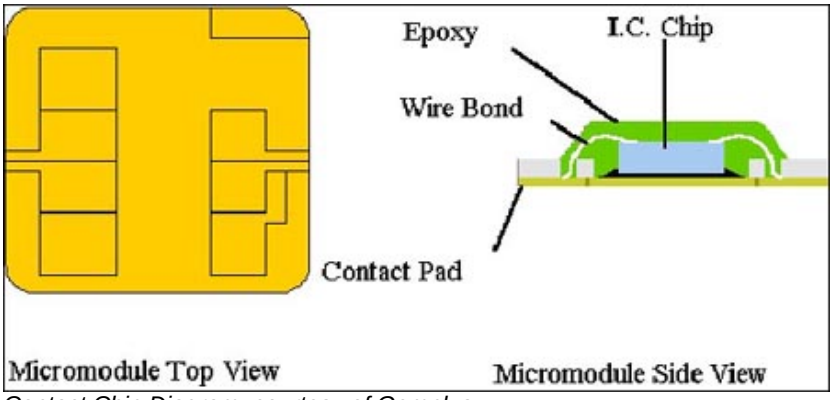
There are two general categories of smart cards: contact and contactless smart cards. A contact smart card requires insertion into a smart card reader with a direct connection to a conductive micromodule on the surface of the card (typically gold plated). It is via these physical contact points, that transmission of commands, data, and card status takes place.



This diagram shows the micromodule embedded into the plastic substrate or card. Prior to embedding, a cavity is formed or milled into the plastic card. Then either a cold or hot glue process bonds the micormodule to the card.

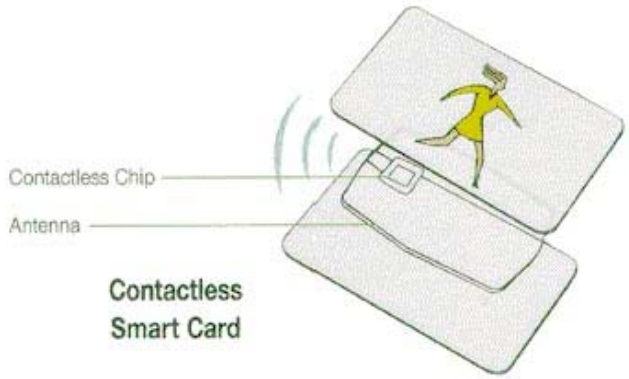
Image courtesy of Gemplus

Below is a contact micromodule which is embedded into a plastic substrate.



Contact Chip Diagram, courtesy of Gemplus

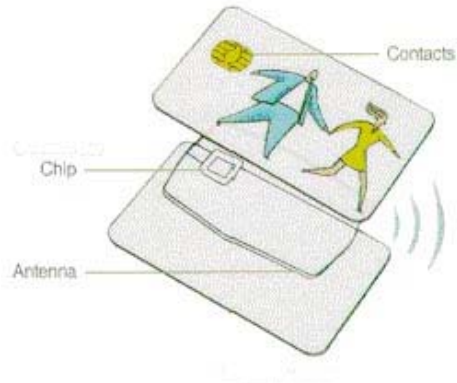
A contactless card requires only close proximity to a reader. Both the reader and the card have antenna and it is via this contactless link that the two communicate. Most contactless cards also derive the internal chip power source from this electromagnetic signal. The range is typically two to three inches for non-battery powered cards, and this is ideal for applications such as mass transit which require very fast card interface.



This diagram shows the top and bottom card layers which sandwich the antenna/chip module. The antenna is typically 3 - 5 turns of very thin wire (or conductive ink), connected to the contactless chip.

Image courtesy of Gemplus

Two additional categories, derived from the contact and contactless cards are Combi cards and Hybrid cards. A Hybrid card has two chips, each with its respective contact and contactless interface. The two chips are not connected, but for many applications, this Hybrid serves the needs of consumers and card issuers. Just emerging is the Combi card which in a single chip card with a contact and contactless interface. With Combi cards, it is now possible to access the same chip via a contact or contactless interface, with a very high level of security. The mass transportation and banking industries are expected to be the first to take advantage of this technology.



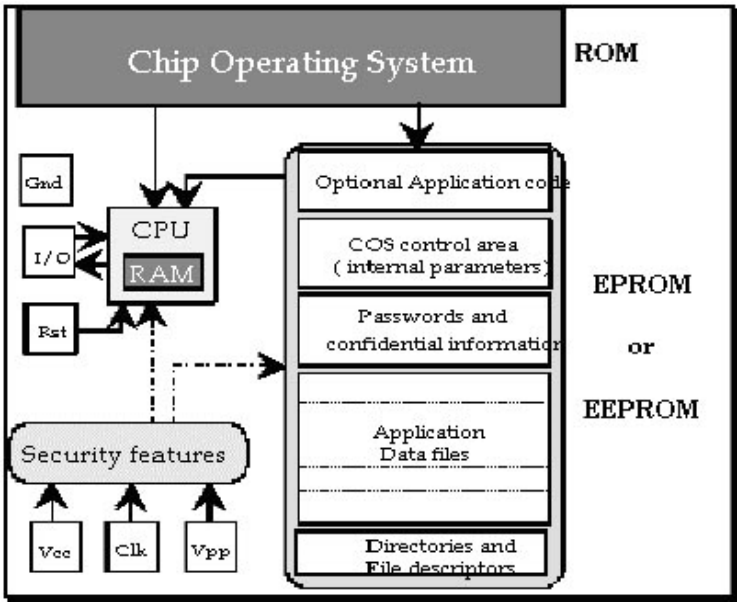
This shows both the contact and contactless elements of the card. A Combi Card has only one chip while a Hybrid card has two.

Image courtesy of Gemplus

The chips used in all of these cards fall into two categories as well: microprocessor chips and memory chips. A memory chip can be viewed as small floppy disks with optional security. Memory cards can hold from 103 bits to 16,000 bits of data. They are less expensive than

micprocessor cards but with a corresponding decrease in data management security. They depend on the security of the card reader for their processing and are ideal when security requirements permit use of cards with low to medium security.

A microprocessor chip can add, delete and otherwise manipulate information in its memory. It can be viewed as a miniature computer with an input/output port, operating system and hard disk. Microprocessor chips are available 8, 16, and 32 bit architectures. Their data storage capacity ranges from 300 bytes to 32,000 bytes with larger sizes expected with semiconductor technology advances. Their ability to download not just data but applications is being advanced by Sun with JavaCard technology and Mondex with Multos.



Microprocessor Chip Diagram, courtesy of Gemplus

Standards

The basic smart card standard is the ISO 7816 series, part 1-10. These standards are derived from the financial ID card standards and detail the physical, electrical, mechanical, and application programming interface to a contact chip card.

Applications

The list of potential applications for smart card technology would be too long for this primer. Instead, listed below are some of the major applications seen around the world.

There are over 300,000,000 GSM mobile telephones with smart cards which contain the mobile phone security and subscription information. The handset is personalized to the individual by inserting the card which contains its phone number on the network, billing information, and frequently call numbers.

Almost every small dish TV satellite receiver uses a smart card as its removable security element and subscription information. There are over 4 million in the US alone between DirectTV, USSB and Echo Star. There are millions more in Europe and Asia.

The Financial industry has been quick to adopt smart card technology in various countries around the world. Every French Visa Debit card (over 25,000,000) has a chip in it. In Germany, about 40,000,000 banking cards have been issued. EuroPay, MasterCard, and Visa all have smart card programs for their bank members. In the Portugal and Singapore, the national banking networks have launched electronic purse projects. Proton has worked with its banking partners to issued over 25,000,000 electronic purse cards in several countries.

Various countries with national health care programs have deployed smart card systems. The largest is the German solution which deployed over 80,000,000 cards to every person in Germany and Austria.

There are over 100 countries world wide who have reduced or eliminated coins from the pay phone system by issuing smart cards. Germany, France, UK, Brazil, Mexico, and China have

major programs.

Other applications for smart cards include computer/internet user authentication and non-repudiation, retailer loyalty programs, physical access, resort cards, mass transit, electronic toll, product tracking, national ID, drivers license, pass ports, and the list goes on.