EUROSMART

The Voice of the Smart Security Industry

White Paper on the Durability of Smartcards for Government eID

July 2008

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To be successful, a Government eID smartcard program faces many trade-offs. The right combination of components for the complete use chain must be carefully selected and qualified to ensure that the card will meet the extended life requirements of Government eID cards and does not have to be reissued before its expected life time. This White Paper by Eurosmart aims at providing an objective approach on topics to be addressed when selecting a suitable platform for a government eID program.

Contents:

1. Smartcard types overview

- Contact
- Contactless
- Hybrid
- Dual interface

In the following chapters, different interface technologies are considered.

Contact

Microcontroller smartcards, as defined in the ISO/IEC-7816 standard, have a metallic chip contact pad embedded on the surface of the card and must be inserted into a smartcard reader to make a direct connection for the transfer of data. Five years life has been widely achieved for contact cards in the financial card market for many years. In order to reach a longer life-span for government eID smartcard projects, specific card body materials and advanced mechanical chip embedding technologies have been developed.
As current international eID schemes in more than 15 countries are practically all based on contact chip interface, it is fair to say that this is a field-proven and durable technology.

Contactless

Contactless smartcards, as defined in the ISO/IEC-14443 standard, have no contact pad and instead use radio waves to communicate with card readers. The connection is achieved through electromagnetic induction between an antenna in the reader and an antenna embedded between layers of the smartcard body. Contactless smartcard durability is assisted by not requiring physical contact with readers. The level of industry experience of a life-span of 10 years with contactless cards is limited, since most usage concentrates on applications where the card has an expected life-span of 2 to 3 years, like transportation cards or employee badges. Contactless cards, with properly selected card body material, are currently considered to have up to 10 years life time despite the limited field experience. Contactless reader infrastructure at country borders is growing thanks to the introduction of ePassports.

Hybrid

Hybrid smartcards, as defined in ISO/IEC-7816 and ISO/IEC-14443 standards, have dual chips, with one connected via a contact interface and another connected via a contactless interface. They are essentially two smartcards in a single card body, with no communication between the two chips that provides clear distinction between contact and contactless applications and accessible data. The challenge of this technology is the durability of both contact and contactless interface, with a suggestion that dual interface cards are the better option in terms of durability.

Dual interface

Dual interface smartcards, as defined in ISO/IEC-7816 and ISO/IEC-14443 standards, have both contact and contactless connections to a single chip in the same card. Dual interface smartcards are a more recent development with few large-scale field studies available. With first Hybrid smartcards cases emerging, up to 10 years warranty can be considered despite the limited field experience. These views are largely based on internal test results and knowledge of the manufacturing processes. The advantages of dual interface cards are that they provide flexibility in terms of contact and contactless reader infrastructure and may retain (limited) functionality even when one of the interfaces fails.

2. Main drivers influencing smartcard type selection

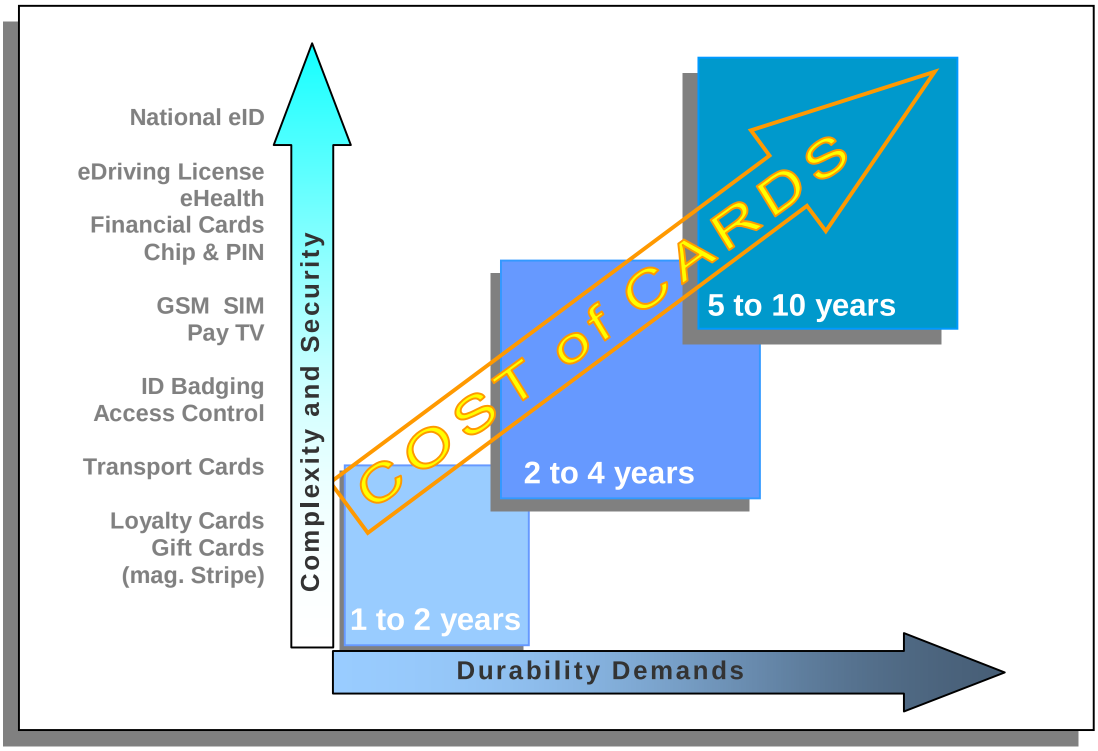
- Card durability
- Cost
- Impact on the infrastructure
- Ease and speed of use

Card durability

Identity document replacement is costly whatever the technology. Card replacement costs at population scale could represent one cost elements of a National ID project. So a careful evaluation of smartcard durability factors to ensure a minimum guaranteed card life can have significant financial benefits. Longer card lifetime results in more convenience for citizen.

Cost

Higher security requirements and improved durability have a direct impact on the cost of cards.



Assuming that contact, contactless, dual interface and hybrid cards are using equivalent technology, the following table illustrates a rough guidance on the indexed technology price (contact being set at level A). The complete cost of a smartcard depends on various factors as the microcontroller, OS, inlay and manufacturing costs, all of which may vary by case by case and depending on the supplier.

Contact	= A
Contactless	= A x 130-150%
Dual	= A x 150–170%
Hybrid	= A x 180–220%

Impact on the infrastructure

It is also often the case that a new project could make use of previously installed reader infrastructure, including Personal Computer readers, which currently tends to be contact-based because contact smartcards are already widely used. If there is an existing reader infrastructure available, governments should consider utilizing it also in the eID scheme.

Ease and speed of use

In some use cases, ease or speed of use of the smartcard may prove to be the most significant factor influencing smartcard type choice. If the card is intended to be used at a work-desk or counter, then speed of use is not so relevant and a contact smartcard may be the best solution for e-government and other digital signature applications. On the other hand, for transportation or access control applications, where speed of flow through a check-point is more important, a contactless smartcard may be the better choice.

3. Main card body materials

- PVC
- Polyester
- Composites
- Polycarbonate

PVC

PVC is the least expensive of the main card body materials. It is used for both contact and contactless cards, but generally has a shorter life expectancy than other card body materials, due to a lower resistance to heat, UV and bending stress, which can cause premature de-lamination and card body breakage. Thus PVC can not be recommended for a government eID project.

Polyester

Polyester is a large family of plastics with a lot of varieties (eg. PET-F, PET-G). Due to these varieties polyester card bodies can differ in durability. But there are polyester combinations from various manufacturers with very high thermal, mechanical and chemical resistance.

Composites

In composite cards, different materials are combined to adapt the card structure for certain applications.

Polycarbonate

Polycarbonate is a rigid and durable card body material with high resistance against heat, flexing and UV.

The choice of card body material has direct impact on the durability and security of the product and also influences the card body printing and finishing.

4. Personalization

Laser engraving

In laser engraving data e.g. photograph is burnt inside the card body material (typically polycarbonate), not to the surface.

Dye Sublimation

In dye sublimation, also known as Dye Diffusion Thermal Transfer (D2T2), data is permeated into the surface of the card by heating ink. This technique enables color data (e.g. photo). Dye sublimation is coupled with the lamination of a protective layer in order to provide prolonged lifetime, as described below.

Re-transfer printing

In re-transfer printing, the data e.g. color photo, is first transferred to a carrier foil and from there onto the card surface. It can be applied on a wider range of materials than dye sublimation.

Card finishes

For the case of dye sublimation personalization, the smartcard industry offers a broad range of card protection overlays, including topcoats, clear laminates and secure polyester laminates which can include high resolution (or holographic) security images and advanced security optical devices. In the case of laser-engraving, no separate card finishing is needed as the personalized data is inside a solid card body.

5. Physical and mechanical factors affecting card durability

- Manufacturing processes
- Chemical Influences
- Heat (warping)
- Moisture
- Ultraviolet Light
- De-lamination
- Customer usage patterns

Card durability is becoming a significant consideration as government ID applications for smartcards begin to expand and as such cards are being carried long-term in wallets, pockets and purses. The card industry has a plethora of materials and processes available to meet nearly any card requirement. The selection of materials and processes has trade-offs. It is important that users have the necessary tools to evaluate the trade-offs in a consistent manner, in order to make an informed choice of materials and processes.

Manufacturing processes

As the government ID products are highly sophisticated and complex products, smartcard durability depends on the know-how and the experience of the smartcard manufacturer and its manufacturing processes.

Chemical influences

The plasticizers or tanning agents used to construct wallets can penetrate a smartcard surface and in the case of card body surface printing extract the dyes used to print photos and other images. The same holds true for skin oils, certain cosmetics, petrol, and leather treatment chemicals. The application of either laser-engraving or implementation of a high quality durable laminate can provide strong protection against most forms of chemical damage.

Heat

Heat (for example from sunlight when leaving a card in the window of a car) can cause significant damage by warping and distortion to most smartcard body materials. PVC in particular can suffer heat damage at temperatures of around 60° C whilst Polycarbonate and certain composites can withstand temperatures above 120°C.

Moisture

Humidity, perspiration, and other moisture can attack or weaken adhesion of poor quality topcoats and laminates and cause premature image failures. The use of high durability laminates or polycarbonate matched to the card body properties will protect a card against moisture damage.

Ultraviolet Light

In case of surface printed personalisation, prolonged exposure to sunlight and other UV sources can fade printed images on plastic cards, causing colour washout, pixelated images and partial characters. UV exposure can also degrade some protective layers and laminates more than others. Careful selection of printing and finishing technologies can reduce the effects of UV exposure.

De-lamination

For the best lamination results, no glues or other adhesives should be used. For instance, PVC cards are assembled using adhesives and are thus more vulnerable to de-lamination than polycarbonate or polyester cards which have been laminated using heat.
For personalization purposes, some card body materials have better adhesion qualities with certain laminates and topcoats than others. The selection of the most suited laminate

for the card body material being used is crucial in avoiding premature separation of laminates from the card body.

Customer usage patterns

Customer usage patterns can have a significant impact on card life. The majority of banking cards currently use a contact interface, are made from PVC, are normally held in a protective wallet or purse and are typically used an average of 2-3 times per week. These cards tend to have a life expectancy of 2-3 years mainly due to the PVC material.

By comparison, transport cards tend to use a contactless interface, are often kept with other items in a pocket or handbag and are typically used an average of 10-12 times per week. Although these cards are generally used far more frequently, they tend to have life expectancy of 3-5 years.

Identity cards, today mainly based on contact interface, with contactless, hybrid and dual interfaces emerging, tend to be used far less frequently than either banking or transport cards and are generally better protected by the user and tend to be made using higher quality card body materials with the life time expectation of up to 10 years.
But it has to be considered that not the frequent usage of an ID card in a card reader is the main stress factor for an ID card but the daily wear and tear. Especially the handling of wallet (if the ID card is kept in it) could unpredictably influence an ID card's life. In a wallet an ID card could be exposed to contacts with coins or to long term bendings.

6. Durability testing standards

The above mentioned physical and mechanical factors affecting card durability and life time call for a reliable and comprehensive set of criteria and test methods.

ANSI (American National Standards Institute) has been working on card durability for 12 years and has developed and published the ANSI NCITS 322-2002 - Card Durability Test Methods.

The following is a typical set of practical tests selected from existing international standards to provide an indication of the durability of the physical body of a card and the related components. The tests are designed to stress the components of a card, namely, antenna durability, antenna-chip connection durability, layer sturdiness and bonding, chip stability, temperature resistance, etc.

Peel strength - measure the peel strength between card layers.
Standards referenced:
ISO 7810 § 8.8 / ISO 10373-1 § 5.3 / ANSI NCITS 322-2002 (5.1) / ISO 10373-1 § 5.3.2
Performed at 90°C and 180°C.
Any layer shall possess a minimum peel strength of 0.35 N/mm (2 lbf/in). If the overlay tears during the test, this signifies that the bond is stronger than the overlay, which is automatically deemed acceptable.

Resistance to chemicals - verify card remains within the dimensions and warpage requirements after exposure to chemical contaminants.

Standards referenced:
ISO 7810 § 8.4 / ISO 10373-1 §§ 3.2, 5.4 / ISO 10373-1 § 5.4.1-2.
The structural reliability shall remain in compliance for dimensions and warpage.

Card dimensional stability and warpage with temperature and humidity - verify card remains within the dimensions and warpage requirements after exposure to specified environmental temperature and humidity.
Standards referenced: ISO 7810 §§ 8.5 / ISO 10373-1 §§ 3.2, 5.5.
Temperature ranges from –35°C to +50°C (± 3°C).
Relative humidity ranging from 5% to 95% (± 5%).
Minimal exposure time: 1 hour.
Rest time in default test environment: 24 hours.

Dynamic bending stress - verify card's structural stability and endurance to bending stress.
Standards referenced: ISO 7816-1, Annex A.1 / ISO 10373-1 §§ 3.2, 5.8.
Bend card vertically and horizontally - Minimum of 1000 bending cycles.

Dynamic torsional stress - verify card's structural stability and endurance to torsion stress.
Standards referenced: ISO 7816-1, Annex A.2 / ISO 10373-1 §§ 3.2, 5.9.
Apply torsion at 0.5 Hz and 15° ± 1° - Minimum of 1 000 torsion cycles.

Ultraviolet light - verify card remains within conformity after exposure to ultraviolet light.
Standards referenced: ISO 7816-1 § 4.2.1 / ISO 10373-1 §§ 3.2, 5.12.
Wavelength is 254 nm - exposure time: 10 minutes to 30 minutes.

X-rays - verify card remains within conformity after exposure to X-rays.
Standards referenced: ISO 7816-1 § 4.2.2 / ISO 10373-1 § 5.13.
Expose both sides of card to X-rays.

3 wheel Test - verify card remains mechanically reliable after subjecting the card to the stresses applied by the three steel wheels test equipment.
Standards referenced: ISO 10373-3, A.1+2.

Note: after performance of each of the previous tests, the card shall be testably functional (defined in ISO 10373-1:1998(E) § 3.2) and the card shall be operationally functional (i.e. card shall return a compliant ATS) and all laminations shall remain firmly bonded together.

Durability tests are generally performed by vendors to ensure that the product meets the expectations of the customer and, above all, will match the warranty provided to the customer.

7. Summary and conclusion

There are multiple factors defining the most suitable government eID solution.

Different types of communication interfaces are suitable for different applications. For National eID (or online-access to governmental electronic services through internet, for example), it is convenient and secure to implement contact interface card. For transportation or travel application, contactless interface is the most suitable one. Ideally, from the application point of view, these two interfaces can be implemented on same card platform (dual/hybrid card) for the broadest range of applications.

Card durability can be heavily impacted by the card body selection and subsequent intervention on it. Therefore, the effects of personalisation, printing and finishing on the durability of the finished card needs to be carefully considered. Wise selection of printing, personalisation and finishing technologies, properly matched to the choice of card body materials, chip insertion and connection methods can extend card life significantly.

Typically the card validity period is also affected by Public Key Infrastructure policy and possible need to issue every few years new PKI keys for citizens. Thus card life cycle may in fact be dominated by reasons unrelated to physical microprocessor or card body durability.

To be successful, a smartcard program faces many trade-offs and the right components for the complete use chain must be carefully selected and qualified to ensure that the card meets the expected performance levels. We would recommend that you discuss all aspects of smartcard design with your smartcard manufacturer, as early in the project planning phase as possible, to ensure that it will meet the extended life requirements of Government ID cards and does not have to be reissued before its expected life time.

In the smartcard supplier selection process it is also of utmost importance to look for a financially stable company with remarkable references and track record.

Eurosmart is an international non-profit association located in Brussels and representing 25 companies of the smart security industry for multi-sectors applications. Founded in 1995, the association is committed to expanding the world’s smart secure devices market, developing smart security standards and continuously improving quality and security applications.

Manufacturers of smart cards, semiconductors, terminals, equipment for smart cards system integrators, application developers and issuers gather and work into dedicated working groups on communication and marketing, security, electronic identity and new form factors, and prospect emerging markets. Members are largely involved in political and technical initiatives as well as research and development projects at the European and international levels

Eurosmart is acknowledged as representing "the Voice of the Smart Security Industry".

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