Smart Card Technical Introduction
Contents

- Introduction to Smart Card Technology
  - Contact
  - Contactless
- Secure Smart Card Printing
- Why Use Smart Cards?
  - Existing Systems
  - Smart Card Security Features
- Smart Card Market
- Smart Card Applications
Contact Smart Card
What is a Smart Card?

- A credit card sized (ID-1) plastic card with an IC chip on board
- Conforms to ISO-7816
Components of a Contact Smart Card

- **A smart card comprises 3 parts**
  - Contact Disc
  - Chip
  - Plastic Body with Cavity
Contact Disc

- A contact disc with a chip is called a **micro-module**
  - Usually composed of 6 or 8 contacts
    - 6 contacts – usually for memory cards & low end CPU cards

- **Module**
  - Usually square or oval
  - Can have different patterns defining the contacts
  - Contact position complies with **ISO-7816-2**

- The Answer-To-Reset value will indicate if it is a CPU card
  - Cannot visually tell the card type based on the contact disc
Micro-Module Manufacturing
Card Manufacturing
Smart Card IC Family

- Contact Memory Card
  - Infineon, Atmel, ISSI (Infineon/Atmel compatibles)
- Contact CPU Card
  - GSM SIM, Smart Debit/Credit EMV Card
  - National smart card (banking / ID card)
- Dual Interface CPU Card
Category by Technology

- Smart Card
  - Contact
  - Contactless
  - Dual Interface
Category by Security

Smart Card

- Memory
  - Payphone
  - Proprietary applications

- MCU
  - GSM-GSM11.11
  - Banking - EMV
  - Proprietary applications

- Crypto
  - E-Identification
  - E-commerce
  - M-commerce
  - GSM11.11,11.14
Types of Contact Memory Cards

- **Memory Card**
  - **Free Access I2C Card**
    - Atmel / ISSI / Microchip: 24C01, 02, 04, 08, 16,..
  - **Token Card** (1st Generation Phone Card)
    - ST-Microelectronics: ST1305
    - Infineon: SLE4406
  - **Protected Memory Card**
    - ST-Microelectronics: ST1333, ST1335
    - Infineon: SLE4436, SLE5536
    - 4442 memory card: 256 bytes
    - 4428 memory card: 1 Kbyte
  - **Active Authentication Token Card** (2nd Generation Phone Card)
    - ST-Microelectronics: ST1333, ST1335
    - Infineon: SLE4436, SLE5536
Contact Card Chip

<table>
<thead>
<tr>
<th>Memory</th>
<th>MCU</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chip Manufacturers</strong></td>
<td><strong>Chip Manufacturers</strong></td>
</tr>
<tr>
<td>• Atmel</td>
<td>• ST Microelectronics</td>
</tr>
<tr>
<td>• Infineon</td>
<td>• Atmel</td>
</tr>
<tr>
<td>• Infineon compatibles</td>
<td>• Renesas</td>
</tr>
<tr>
<td>Card Manufacturers embed the chip in card</td>
<td>Card manufacturers must design the chip operating system</td>
</tr>
<tr>
<td></td>
<td>There are also COS vendors</td>
</tr>
</tbody>
</table>
# Plastic Card Body

<table>
<thead>
<tr>
<th>Material</th>
<th>Advantage</th>
<th>Disadvantage</th>
<th>Usage</th>
</tr>
</thead>
</table>
| PVC      | - Allows metallic color printing, hot stamping, embossing and adding magnetic stripe | - Cannot withstand high temperature (e.g. temperature inside a car), hence not suitable for parking & tolling applications | - Banking card  
- Loyalty card |
| High temp. PVC | - Can withstand high temperature | | - GSM SIM card (requires the card to be able to withstand up to 85°C) |
| ABS      | - Commonly used for GSM SIM cards & telephone prepaid cards. | - Cannot allow addition of magnetic stripe, hot stamping, metallic color printing and embossing | - GSM SIM card  
- Telephone prepaid card |
| PET      | - Can withstand high temperature | - More expensive than PVC (about $0.05 to $0.10) | - Parking and tolling card, National ID card, Passport, Driver’s license |
| PC       | - Can withstand high temperature  
- Highly durable and light weight  
- Stronger than PVC cards | - Expensive | - National ID card, Passport, Driver’s license |
Memory Card Security Architecture

Hard-wired Logic

Memory

Security Access Control
CPU Card Architecture
Smart Card Memory Capacity

- Memory size is described in bits / bytes
- Memory size refers to the application memory
  - EEPROM - erasable, if authorized
- Memory card storage: 104 bits to 16 Kbits
- CPU card - 8bits/16 bits, 8051 or 6805 core
  - ROM - 6Kbytes to a few hundred Kbytes
  - RAM - 100 bytes to a few Kbytes
  - EEPROM - 512 bytes to 1 Mbyte
  - Flash CPU card is also available
Smart Card Standard – ISO 7816

- Part 1: Physical Characteristics
- Part 2: Dimensions & Locations of Contacts
- Part 3: Electronic Signals & Transmission Protocol
- Part 4: Inter-industry Command for Interchange
- Part 5: Numbering System & Registration Procedure for Application Identifiers
- Part 6: Inter-industry Data Elements
- Part 7: Inter-industry Structured Card SQL
- Part 8: Security Related Security Commands
Smart Card Standard – ISO 7816

- Part 9: Additional Inter-industry Commands & Security Attributes
- Part 10: Electronic Signals & ATR for Synchronous Card
- Part 11: Personal Verification through Biometrics Method
- Part 12: USB Electrical Interface and Operating Procedure
- Part 13: Cards for Application Management in a multi-application environment
- Part 15: Cryptographic Information Application
ISO-7816 Part 1: Physical Characteristics

- UV light
- X-ray
- Contacts Surface Profile
- ESD
- Torsion

- Heat dissipation
- Bending
- Mechanical strength of card, contacts
- EMI
ISO-7816 Part 2

Class A = 5V
Class B = 3V
Class C = 1.8V
ISO-7816 Part 2: Location & Assignment of Contacts

ISO POSITION

AFNOR POSITION
ISO-7816 Part 3: Cold Reset
ISO-7816 Part 3: Warm Reset
ISO-7816 Part 3: Answer to Reset

TS = Initial Character
T0 = Format Character Y1,K
TA1 = FI,DI
TB1 = II,PI1
TC1 = N
TD1 = Y2, T

TA2 = Specific Mode
TB2 = PI2
TC2 = Specific
TD2 = Y3, T
TD2 = Y3, T

T1..Tk = Historical Characters
ISO-7816 Part 3

- **T=1 (Block Protocol)**
  - TBi(i>2) BWI, CWI
  - BWI = Block Waiting Integer
  - CWI = Character Waiting Integer

- **T=15 (Additional Global Interface Bytes)**
  - TAi(i>2) = SI, CI
  - SI = Sleep Mode Indicator
  - CI = Class A (5V), Class B (3V), Class AB
ISO-7816 Part 3: T=0 TPDU

ISO-IN Command

ISO-OUT Command

PB = INS : Send me next byte
PB = INS : Send me all bytes
ISO-7816 Part 3: Transmitting a Byte

No transmission error

Transmission error
ISO-7816 Part 3: T=1 TPDU

ISO-IN Command

ISO-OUT Command

ISO-IN & OUT Command
## ISO-7816 Part 3: T=1 TPDU Frame

<table>
<thead>
<tr>
<th>PROLOGUE</th>
<th>INFORMATION</th>
<th>EPILOGUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA/ID</td>
<td>INFORMATION FIELD</td>
<td>EDC</td>
</tr>
<tr>
<td>1 byte</td>
<td>0 to 254 bytes</td>
<td>1 or 2 bytes</td>
</tr>
<tr>
<td>PC/B</td>
<td>LEN</td>
<td></td>
</tr>
<tr>
<td>1 byte</td>
<td>1 byte</td>
<td></td>
</tr>
</tbody>
</table>

PCB conveys the type of frame

- I-BLOCK (Information Block)
- R-BLOCK (Receive Ready Block)
- S-BLOCK (Supervisory Block)
### ISO-7816 Part 4: APDU FORMAT

**Case Command Response**

<table>
<thead>
<tr>
<th>Case</th>
<th>Data 1</th>
<th>Data 2</th>
<th>CLA</th>
<th>INS</th>
<th>P1</th>
<th>P2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>no data</td>
<td>no data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>no data</td>
<td>data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>data</td>
<td>no data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>data</td>
<td>data</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

31
ISO-7816 Part 4: File Organization
ISO-7816 Part 4: File Structures

TRANSPARENT FILE

- Header
  - System Information
- Body
  - Sequence Of Byte Application Data

LINEAR FIXED FILE

- Header
  - System Information
- Body
  - Record #1
  - Record #2
  - Record #3
  - Rest of records
  - Last Record #N
ISO-7816 Part 4: File Structures

LINEAR VARIABLE FILE

- Header
  - System Information
- Body
  - Record #1
  - Record #2
  - Record #3
  - Rest of records
  - Last Record #N

CYCLIC FILE

- Header
  - System Information
- Body
  - Record #1
  - Record #2
  - Record #3
  - Rest of the records
  - Last Record #P

Advanced Card Systems Ltd.
Card & Reader Technologies
ISO-7816 Part 4: Inter-industry Commands

- ERASE BINARY
- VERIFY
- MANAGE CHANNEL
- EXTERNAL AUTHENTICATE
- READ RECORD(S)
- READ BINARY
- SELECT FILE
- INTERNAL AUTHENTICATE
- GET CHALLENGE
- GET RESPONSE
- ENVELOPE
- GET DATA
- WRITE BINARY
- WRITE RECORD
- UPDATE BINARY
- PUT DATA
- UPDATE RECORD
- APPEND RECORD

And many more commands with the new ISO-7816 part 4!!!
Contactless Technology
Types Of RFID

- **Active Tag**
  - On-board power source
  - Requires less power from the reader
  - Longer read/write range
  - Limited operating life
  - More expensive

- **Passive Tag**
  - Obtains operating power from the reader
  - Higher-powered reader
  - Shorter read range
  - Unlimited life time
  - Smaller, lighter, and less expensive
### RFID Operating Frequencies

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>Characteristics</th>
<th>Typical Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low: 100-500 kHz</td>
<td>➢ Short to medium read range</td>
<td>➢ Access control</td>
</tr>
<tr>
<td>125kHz: Low Frequency</td>
<td>➢ Inexpensive</td>
<td>➢ Animal identification</td>
</tr>
<tr>
<td></td>
<td>➢ Low reading speed</td>
<td>➢ Inventory control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>➢ Car immobilizer</td>
</tr>
<tr>
<td>Intermediate: 10-15 MHz</td>
<td>➢ Short to medium read range</td>
<td>➢ Access control</td>
</tr>
<tr>
<td>13.56MHz: High Frequency</td>
<td>➢ Potentially inexpensive</td>
<td>➢ Smart cards</td>
</tr>
<tr>
<td></td>
<td>➢ Medium reading speed</td>
<td></td>
</tr>
<tr>
<td>High: 850-950 MHz (UHF)</td>
<td>➢ Long read range</td>
<td>➢ Railroad car monitoring</td>
</tr>
<tr>
<td>2.4-5.8 GHz (SHF)</td>
<td>➢ High reading speed</td>
<td>➢ Toll collection systems</td>
</tr>
<tr>
<td></td>
<td>➢ Line of sight required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>➢ Expensive</td>
<td></td>
</tr>
</tbody>
</table>
ISO Standards of RFID in 13.56 MHz

SC 17/WG 8
Identification Cards
Contactless
Integrated Circuits

0 - 1 mm
ISO 10536
Close coupled cards
1) Physical Characteristics
2) Dimensions and location of coupling areas
3) Electronic signals and reset procedures
4) Answer to reset and transmission protocol

0 - 10 cm
ISO 14443
Proximity cards
1) Physical Characteristics
2) Radio frequency power and signal interface
3) Initialization and anticollision
4) Transmission protocol

0 - 100 cm
ISO 15693
Vicinity cards
1) Physical Characteristics
2) Air interface and initialization
3) Protocols
4) Registrations of applications / issuers
Components of a Contactless Smart Card

- A contactless smart card comprises of 3 parts
  - Chip
  - Antenna
  - Plastic body (front and back)
Types of Contactless Cards

**Contactless Card**
- Memory or µprocessor chip connected to an antenna. Antenna and module embedded into the plastic card body.
- Low cost solution
  - Full contactless

**Hybrid Card**
- Contactless card with an added contact chip.
  - There is **no link** between the 2 chips.
- Fast time to market
  - High price

**Combi Card**
- Microprocessor chip with the **2 interfaces**.
  - Single OS managing transactions in both modes.
- One single chip
  - Applications and data sharing between contact & contactless
Different Forms of RFID Tags
Contactless for Security Applications

- **Contactless Memory - Mifare**
  - NXP, Infineon, Atmel
  - Prepaid, transportation, physical access

- **Contactless CPU Card - Readily available types**
  - Desfire (for e-purse )

- **Contactless CPU – National standard**
  - China transportation
  - Singapore CEPAS e-purse

- **Contactless CPU – Application standard**
  - EMV – Paypass, Visa-wave
  - ICAO Biometrics Passport
Types of Contactless Cards

- MiFare Ultralight
- ISO -15693 I-code

- Mifare Classics

- DESFire
- Paypass
- Visa-wave
- ICAO passport
How Tag is Powered & How it Communicates

Inductive Coupling

ASK (Amplified Shifted Keying)

Card Reader: Load Modulation
This standard defines:

- Card dimensions (refer to ISO 7810 for ID-1 cards)
- Surface quality for printing
- Mechanical resistance
- UV and X-ray resistance
- Sensitivity to surrounding magnetic fields

The standard introduces the specific terms:

- PICC: Proximity Integrated Circuit Card
- PCD: Proximity Coupling Device (the card reader or terminal)
ISO 14443 Part 2: RF Power & Signal Interface

- This standard defines:
  - Characteristics of power transfer (inductive coupling & communication between PICC & PCD at 13.56 MHz)

- It has 2 different types:
  - Type A Card
    - 100% modulation ASK
  - Type B Card
    - 10% modulation ASK
This standard defines:
- Poll for PICCs entering the field of a PCD
- Format, command frames and timing
- Request(REQ) and Answer To Request(ATQ) commands
- Anti-collision methods for A & B cards:
  - Detects & communicates with 1 out of n cards
  - Relies on a unique ID per card
- It has 2 different types:
  - Type A: Binary search referring to the card UID
  - Type B: Slotted Aloha method
This standard defines:
- A half duplex block transmission protocol, T=CL
- Similar to T=1
- Independent of lower layers
ISO-7816 vs ISO-14443

<table>
<thead>
<tr>
<th>Protocol definition</th>
<th>7816-3 Protocol type T=0 and protocol type T=1</th>
<th>14443-4 Transmission protocol T=CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Card activation</td>
<td>Operating procedure</td>
<td>14443-3 A/B Initialization and anticollision</td>
</tr>
<tr>
<td>Electrical characteristics</td>
<td>Electrical characteristics</td>
<td>14443-2 A/B Radio frequency power and signal interface</td>
</tr>
<tr>
<td>Dimensions and location of the contacts</td>
<td>7816-2 Dimensions and location of the contacts</td>
<td>N.A. A minimum coupling area is defined</td>
</tr>
<tr>
<td>Physical characteristics</td>
<td>7816-1 Physical characteristics</td>
<td>14443-1 Physical characteristics</td>
</tr>
</tbody>
</table>

Contact [ISO 7816]

- Power On
- Receive: Answer to Reset (ATR)
- Exchange Application Protocol Data Units (APDU) (s)

Contactless [ISO 14443]

- Select Command „s“
  - Request A or Request B
  - Anticollision
  - Select
- Send: Request Answer to Select
- Receive: Answer to Select (ATS)
- Exchange Application Protocol Data Units (APDU)
NFC Technology
What is NFC?

GSM SIM card

Communication

NFC-based GSM SIM card

*Note: NFC application can be in the SIM or in the phone with a Java Smart Card chip in the handset.
NFC Handset Architecture

Figure 3-1: NFC Handset Functional Architecture.
What are NFC Tags?

**NFC Tags**

- **Type 1 Tag**
  - ISO-14443 Type A, 106 Kbit/s
  - 96 bytes, expandable to 2 Kbytes, read & rewriteable
  - e.g. Topaz

- **Type 2 Tag**
  - ISO-14443 Type A, 106 Kbit/s
  - 48 bytes, expandable to 2 Kbytes, read & rewriteable
  - e.g. Mifare Ultralight

- **Type 3 Tag**
  - JIS 6319
  - 212, 424 Kbit/s
  - e.g. Felica

- **Type 4 Tag**
  - ISO-14443 A /B, up to 424 Kbit/s
  - e.g. JCOP30, Mifare DESfire
Typical NFC Applications

- **Contactless card and Personal contactless terminal**
  - Automatic Fare Collection
  - Loyalty
  - Credit Card

- **Smart Poster**

- **Blue-tooth pairing**
Secured Smart Card Printing
Secure Printing

- **Main Goal of Secure/Security Printing**
  - Prevent forgery or counterfeiting

- **Typical Application**
  - National ID cards, Passport, Banking cards

- **Typical Examples**
  - UV Printing
  - Microtext
  - Guilloche
  - Multiple laser image (MLI)
  - Watermark
  - Hologram, etc...
Secure Printing
Secure Printing

(Source: HK Immigration Department)
Secure Printing (more examples)

More about hologram

Setup charge for molding may cost US $2,000!
Secure Printing (more examples)
Secure Printing (more examples)

UV light

UV Printing
Secure Printing (more examples)
Glossary for Secure Printing

- **Guilloche**: printed security lines - the layout of intersections and geometry are unique. Guilloches are created from two or more indicated and overlapping lines.

- **Hologram**: a unique form of photographic printing that appears as a flat optical image to the naked eye and provides a three-dimensional effect on a flat surface. Holograms cannot be easily copied and are used for security and aesthetic purposes on cards.

- **Microtext**: involves extremely small texts that are small enough to be indiscernible to the naked eye.

- **MLI (Multiple Laser Image)**: image that can be viewed at different angles.

- **OVI (Optical Variable Ink)**: a high security feature showing different colors as the angle of view changes.
Glossary for Secure Printing

- **UV (Ultraviolet) Printing**: is invisible under regular illumination. By viewing the text/graphic under UV light, they become visible with a yellow colour.

- **Offset printing**: a method of printing that transfers the paint from the printing platform under pressure onto an intermediate elastic rubber surface, and then to the product surface.

- **CMYK (Cyan-Magenta-Yellow-Black)**: a system of color separation for printing.

http://www.smartcardalliance.org/pages/smart-cards-intro-glossary
Why Use Smart Card Technology?
What Can Go Wrong with Existing Systems

- **Magnetic ATM Card**
  - Cloning of card at POS for fund transfer
  - Cloning of card by fake ATM

- **Magnetic Credit Card**
  - Card duplicated during usage
  - Fake card
  - Fake transaction
Installing a magnetic card reader attachment

Magnetic reader attachment installed
RF transmission Camera to capture PIN entry

Transmission to a receiver 200 meters away
What Can Go Wrong with Existing Systems

- Magnetic Payphone Card
  - Buying 5 fake cards for the price of one authentic card
  - Tampering with the value
  - Frequent cleaning of read/write head
  - Local power supply required

- Mobile Phone System
  - Eavesdropping on conversation
  - Cloning of mobile phone during usage or repair
What Can Go Wrong with Existing Systems

- Pay TV
  - Cloning of decoder after establishing customer base

- Logon to Computer System
  - Unauthorized access to computer network
Smart Card Security Features
Smart Card Security Capabilities

- Card Authentication
- Terminal Authentication
- Cardholder Authentication
- Transaction Certification
- Data Confidentiality
Card Authentication

- The terminal ensures that the card is authentic before continuing with the transaction.
- The issuer loads into each card & terminal a secret key before issuance.
- The card must prove to the terminal that the card knows the secret key.
- The card must not expose the secret key during the authentication process.
- Since the card knows the secret key, it must be an authentic card.
Terminal Authentication

- The card ensures that the terminal trying to access the card is a genuine terminal.
- The issuer loads into each card & each terminal a secret key before issuance.
- A genuine terminal must be able to prove that it knows the secret key by presenting the secret key to the card.
- Since the terminal can prove its authenticity, the card grants the terminal the required access rights.
Card Holder Authentication

- The card ensures that only the genuine cardholder can use the card.
- The issuer loads into each card a cardholder PIN.
- The cardholder must prove to the card that he knows the PIN.
- The card grants the cardholder the required access rights since the cardholder is able to present the correct PIN.
- The card can automatically block successive wrong PIN presentation.
- Incorporating biometrics (thumb print, retina/vein pattern, voice, signature dynamics) is also possible.
The issuer loads a unique certification key into the card before issuance.

The terminal sends transaction into the card after successful card, terminal and card-holder authentication.

The card generates an electronic signature of the transaction with the certification key.

The fact that the signature is verified to be correct indicates that the transaction actually took place.

The transaction certificate can be used for non-repudiation and data integrity.
Data Confidentiality

- The issuer loads a unique encryption key into each card before issuance.
- This key is used to encrypt the data between the terminal and the remote host.
The smart card is only one component in a smart card based system implementation.

What you want is a solution.

Using a smart card does not automatically imply security; the system design, together with the smart card, is what makes for security.

A smart card is not always the best solution if the smart card’s capabilities are not fully utilized.
Smart Card Market
<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Telecom</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telecom</td>
<td>1,050</td>
<td>1,390</td>
<td>2,040</td>
<td>2,650</td>
<td>3,200</td>
<td>3,300</td>
</tr>
<tr>
<td><strong>Financial Services/Retail/Loyalty</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Services/ Retail/ Loyalty</td>
<td>280</td>
<td>336</td>
<td>410</td>
<td>510</td>
<td>650</td>
<td>730</td>
</tr>
<tr>
<td><strong>Government/Healthcare</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Government/Healthcare</td>
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<td>60</td>
<td>90</td>
<td>105</td>
<td>140</td>
<td>160</td>
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<tr>
<td><strong>Transport</strong></td>
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<td></td>
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<tr>
<td>Transport</td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>30</td>
<td>30</td>
<td>40</td>
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<tr>
<td><strong>Pay TV</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Pay TV</td>
<td>55</td>
<td>55</td>
<td>65</td>
<td>85</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>Others (including Corp. ID)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (including Corp. ID)</td>
<td>24</td>
<td>27</td>
<td>30</td>
<td>65</td>
<td>65</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,469</strong></td>
<td><strong>1,888</strong></td>
<td><strong>2,665</strong></td>
<td><strong>3,445</strong></td>
<td><strong>4,185</strong></td>
<td><strong>4,400</strong></td>
</tr>
</tbody>
</table>

Source: Eurosmart (http://www.eurosmart.com)
# MCU Cards Shipment (Millions of Units)

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Financial Services/</td>
<td>280</td>
<td>336</td>
<td>410</td>
<td>510</td>
<td>650</td>
<td>730</td>
</tr>
<tr>
<td>Retail/ Loyalty</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Government/ Healthcare</strong></td>
<td>45</td>
<td>60</td>
<td>90</td>
<td>105</td>
<td>140</td>
<td>160</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>15</td>
<td>20</td>
<td>20</td>
<td>30</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td><strong>Others (including Corp. ID)</strong></td>
<td>24</td>
<td>27</td>
<td>30</td>
<td>65</td>
<td>65</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>349</td>
<td>443</td>
<td>550</td>
<td>710</td>
<td>885</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Source: Eurosmart  (http://www.eurosmart.com)
## Memory Card Shipment (Millions of Units)

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telecom</td>
<td>710</td>
<td>580</td>
<td>480</td>
<td>440</td>
<td>380</td>
<td>300</td>
</tr>
<tr>
<td>Financial Services/ Retail/ Loyalty</td>
<td>35</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Government/ Healthcare</td>
<td>20</td>
<td>25</td>
<td>250*</td>
<td>300*</td>
<td>250</td>
<td>170</td>
</tr>
<tr>
<td>Transport</td>
<td>60</td>
<td>73</td>
<td>140</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>Others (including Corp. ID)</td>
<td>20</td>
<td>30</td>
<td>35</td>
<td>80</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>845</strong></td>
<td>738</td>
<td><strong>1,020</strong></td>
<td>970</td>
<td>900</td>
<td>740</td>
</tr>
</tbody>
</table>

*included the Chinese ID at 200 Mu (2006), 250 Mu (2007)

Source: Eurosmart (http://www.eurosmart.com)
## Contactless Cards Shipment (Millions of Units)

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010 (Forecast)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MCU</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Financial Services/ Retail/ Loyalty</strong></td>
<td>60</td>
<td>100</td>
<td>110</td>
<td>140</td>
</tr>
<tr>
<td><strong>Government/ Healthcare</strong></td>
<td>50</td>
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<td>75</td>
<td>90</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td>30</td>
<td>30</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td><strong>Others (including Corp. ID)</strong></td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>170</td>
<td>220</td>
<td>255</td>
<td>310</td>
</tr>
</tbody>
</table>

Source: Eurosmart (http://www.eurosmart.com)
Total Smart Card Reader Market

Source: Frost & Sullivan
Smart Card Reader Market Size

- US$1,500M
- US$120M
- US$120M
- US$80M
- US$35M
- US$80M

- PC-linked readers
- Reader chip in USB tokens
- Pocket readers
- Reader modules used in various bigger machines
- Non-financial transaction terminals
- Financial transaction terminals
Smart Card Applications
Telecommunications Prepaid Card

- Lower infrastructure cost
- Lower maintenance cost
- Cash in advance
  - Unspent money
- Opportunity for new service – Card Roaming
- Opportunity for new markets
- Electronic Purse
No eavesdropping on conversation
No cloning of handsets
Regional roaming
Lower cost of handsets
More value-added services
  ▪ Fixed dialing
  ▪ Advice of charge
  ▪ Short Message Service (SMS)
  ▪ SIM Tool kit
  ▪ And more...
Financial Sector

- **Smart Debit / Credit Card - Europay Master Visa**
  - Online and Offline Transactions
  - No card cloning
  - Value-added services
    - Loyalty
- **Debit Card / Electronic Passbook / Electronic Purse**
  - Security
  - Off-line transaction
  - High availability, speed of service
  - Low cost per transaction
  - Low cost system infrastructure maintenance
Retail

- **Loyalty Card**
  - Collect & analyze customer needs
  - Increase market share
  - Increase profit
  - Provide value-added services
  - Retain customer loyalty

- **Gift Voucher / Prepaid Card**
  - Increase market share
  - Increase profit
Healthcare

- **Health & Insurance**
  - Administrative cost saving through automation
  - Fraud control
  - Waste control
  - Prevention of abuses
  - Medical records
Identification

- Identification card
- Physical access
- Logical access
- Clocking
- Resource booking
- Library card
- Vending
- Staff canteen
Questions?