High-Speed Public-Key based Electronic Cash Using Contactless IC Cards

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Technology Overview

- The world's first implementation of public-key based e-cash technology on dual contact/contactless interface IC cards.
- High-speed payment processing, less than ***<u>0.4 seconds</u>***.

Why are “High-Speed” and “Contactless” needed?

- Contactless allows use just by putting cards near terminals without removing it from your purse.
- High-speed contactless has wide application area:
  - Kiosks, Convenience stores,
  - Public transports (railways, buses), etc.

- Dual interface allows the use of legacy contact IC card terminals.

Why Public-Key Based E-Cash?

- Public-key cryptography is the only solution for valuable versatile e-cash.
  - e.g. Nation-wide general purpose e-cash cards.
- Symmetric cryptography can support only less-valuable local e-cash.
  - e.g. Domestic prepaid cards in a park, or railway’s stored fare cards, etc.

Why “Contactless”not available until now?

- RSA-like public-key cryptography requires co-processor on IC cards, but:
  - Co-processor consists of complex hardware, and consumes too much power;
  - Difficult to implement on contactless IC cards.

Why was E-Cash Slow?

- Slow digital sign generation on IC card
  - Public-key cryptography is much slower than symmetric schemes.
- Slow data communication
  - Contact IC card: 9,600bps
  - Exchange large amount of data
    (e.g. digital signature)
- Inefficient IC card command architecture
  - Lots of interaction between terminal and IC card occurs during a transaction.
    (e.g. transaction management)

Approach

- Elliptic Curve Cryptography (ECDSA*) to reduce computational complexity
- Precalculation – shorten processing time of digital signature generation
- Faster data communication
  - Contactless IC card: 106Kbps (≅10 times faster)
  - Data volume of ECDSA is shorter than that of RSA
- Efficient IC card command architecture
  - Reduce interaction between terminal and IC card

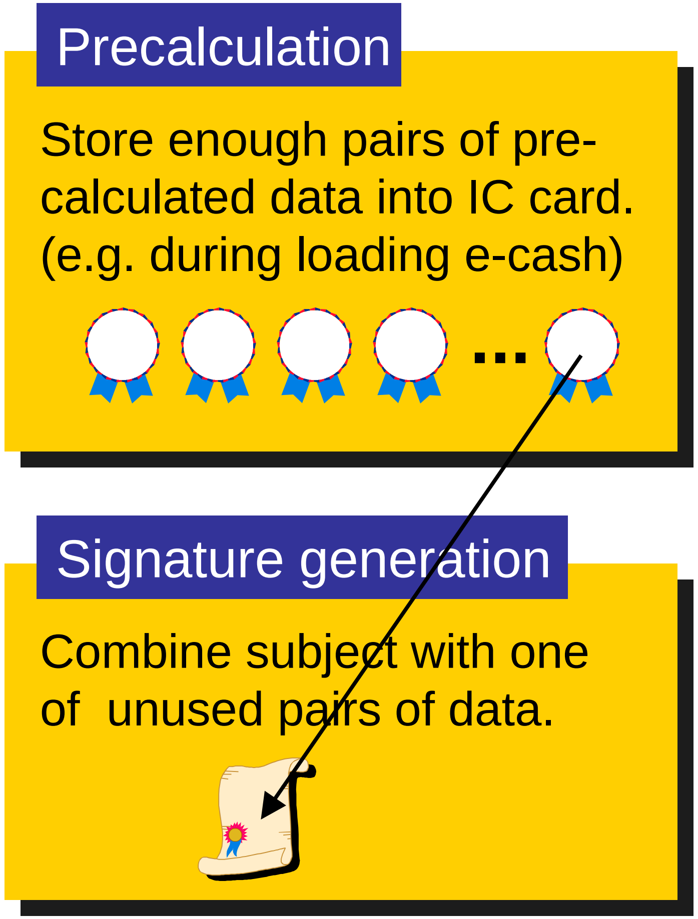
*ECDSA: Elliptic Curve Digital Signature Algorithm

RSA vs. ECDSA

	RSA	ECDSA
Key length	1024 bits	160 bits
Signature data length	128 bytes	42 bytes
Basic operations	Power of 1024 bit-long integers	XOR and arithmetics of 160 bit-long integers
Computational complexity	High	Low
Cryptographic strength	Almost equivalent	

Technique of ‘Precalculation’

- In ECDSA, some parts can be calculated independently from the subject to be signed.
- Precalculation processes finished in advance.
  - During loading e-cash into IC card, or maintenance.
- Shorten signature generation time.



Latest Result

- <u>Payment processing time: ***385**ms*</u> (total)

PC Terminal

15ms

- Terminal authentication
- ECDSA verification
- Transaction management

Communication

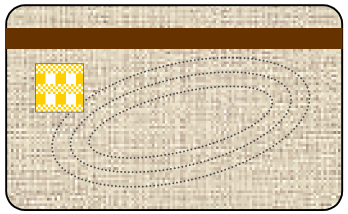
180ms

IC Card

190ms

- Terminal authentication
- ECDSA signature
- Transaction logging

Contactless communication

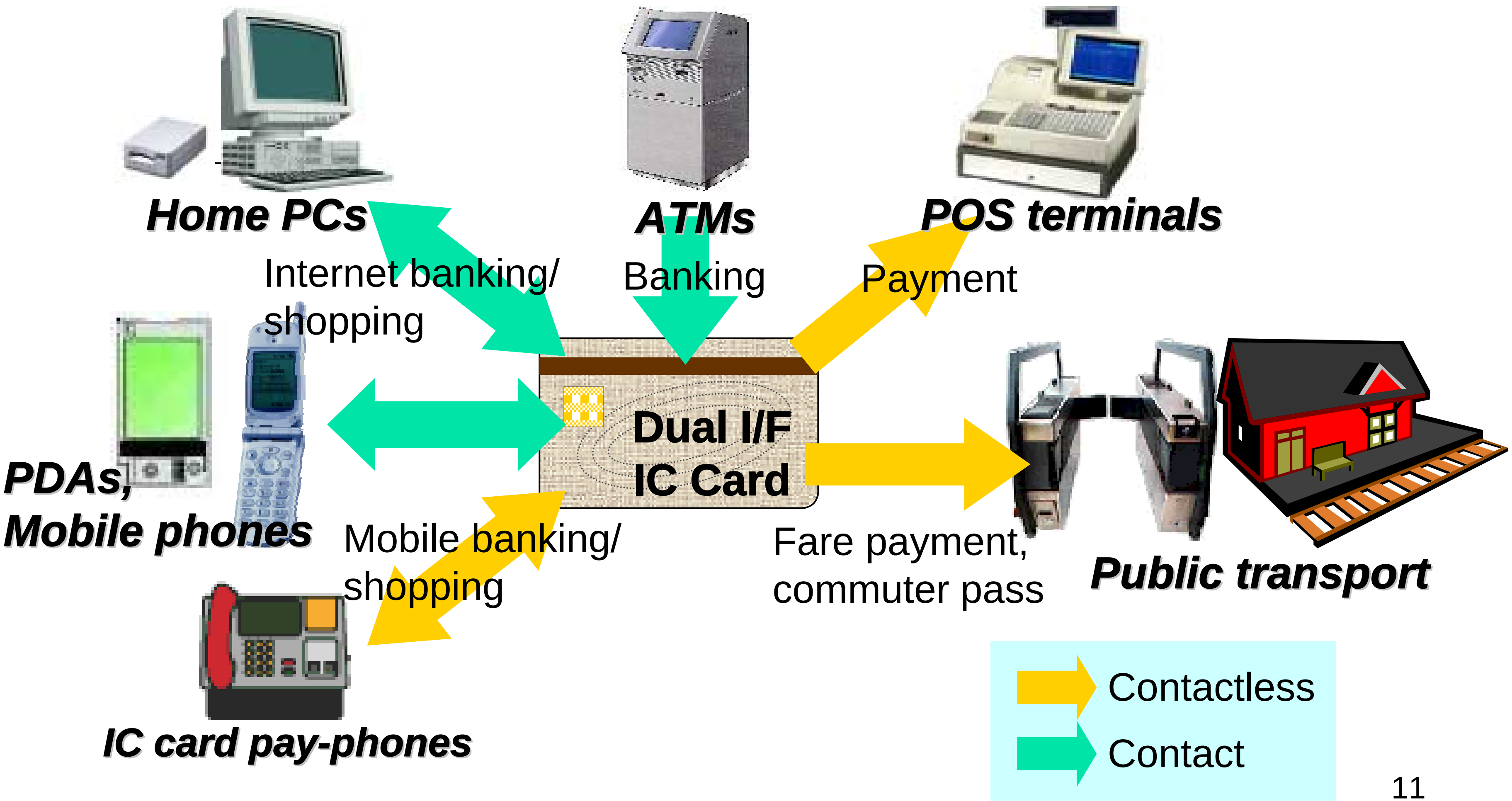


•CPU: PenIII 800MHz
•RAM: 256MB
•OS: Windows98

•Communication interface
- To IC card: 106Kbps
- To Terminal: 115Kbps

•Infineon SLE66CL160S
•CPU: 16bit, 3.39MHz with EC-accelerator
•RAM: 1.2KB
•EEPROM: 16KB

Applications



Demonstration