Extending EMV payment smart cards with biometric on-card verification

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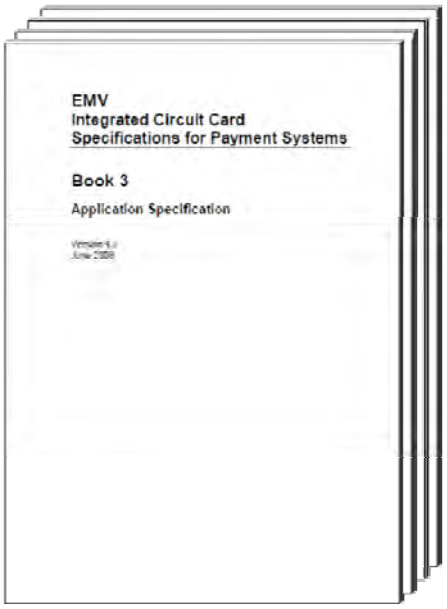
What are EMV cards?

- Debit and credit cards with a microprocessor chip (smart cards)
- Complying with the EMV specifications, the common-ground standard for smart-card based payment systems
- Based on ISO/IEC 7816
- Named after Europay, MasterCard, and Visa, who created the first version of the spec in the 1990s
- Being introduced worldwide because, unlike a magnetic stripe, the chip cannot be cloned



How do EMV transactions work?

- Application selection
- Initiate application processing and read application data
- Offline data authentication using public-key cryptography
- Processing restrictions
- Cardholder verification
- Terminal risk management
- Terminal action analysis
- Card action analysis
  - Transaction certificate (TC): Offline approval
  - Application authentication cryptogram (AAC): Offline decline
  - Authorisation request cryptogram (ARQC): Go online
- Conditionally online processing
- Completion and script processing

Cardholder verification

- Card issuer defines cardholder verification (CV) rules list specifying which CVM to apply
  - Offline PIN
  - Online PIN
  - Handwritten signature on paper

  under what conditions
  - Always;
  - Terminal supports CVM;
  - Transaction is in the application currency and is under/above a value X.
- The terminal processes the CV rules list until
  - A CVM is performed successfully;
  - A mandatory CVM failed;
  - The list is exhausted.

Proposed extensions for biometric cardholder verification

- Define a new CVM for each biometric on-card verification method
- Extend the definitions of the commands used for PIN verification to support biometric on-card verification
- Extend the data elements terminal verification result (TVR), terminal action code (TAC), and issuer action code (IAC) to hold information about biometric cardholder verification
- Add the data elements on the card
  - Biometric information template (BIT): For informing the terminal about properties of the biometric cardholder verification method [ISO/IEC 7816-11].
  - Biometric reference, and
  - Biometric retry counter

Biometric cardholder verification

- Retrieve the BIT
- If the biometric CVM is supported and not blocked,
  - Capture biometric data,
  - Format them according to the BIT,
  - Send them to the card for on-card comparison

Prototype

- Uses Java-card applet for handwritten signature on-card verification
- Comparison of signature dynamics (time series of x and y coordinates) using dynamic time warping (DTW) algorithm

Is handwritten signature on-card verification secure?

- More secure than handwritten signature on paper
- Security depends on quality of the enrolment template – Biometric sample quality assessment at enrolment time is crucial.
- In case of false accepts
  - Chargeback if the customer denies the payment (like for handwritten signature on paper)
- In case of false rejects
  - The card should still offer PIN verification.

Summary and outlook

- MSc project showed feasibility of extending EMV cards with biometric on-card verification
- We argue that handwritten signature on-card verification would be
  - User-friendly,
  - Secure, and
  - Privacy-preserving
- Things to do before a market launch:
  - Amending the EMV specifications
  - Porting from Java card to native-code smart cards in order to reduce computing time
  - Integration of signature pad into point-of-sale terminals
  - Security evaluation

Confirm the amount

Insert the card

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Sign your name

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Payment authorised by card

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