



MasterCard
Worldwide

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The practical application of cryptography to international card payments

EMV heuristics and standards

Colloquial expression of requirements

Consumer

- No unauthorised debits to their account
 - No modifications to an authorised transaction
 - No omissions of authorised transactions
 - Privacy
 - Audit and enquiry trail
 - Consumer protection checks and balances

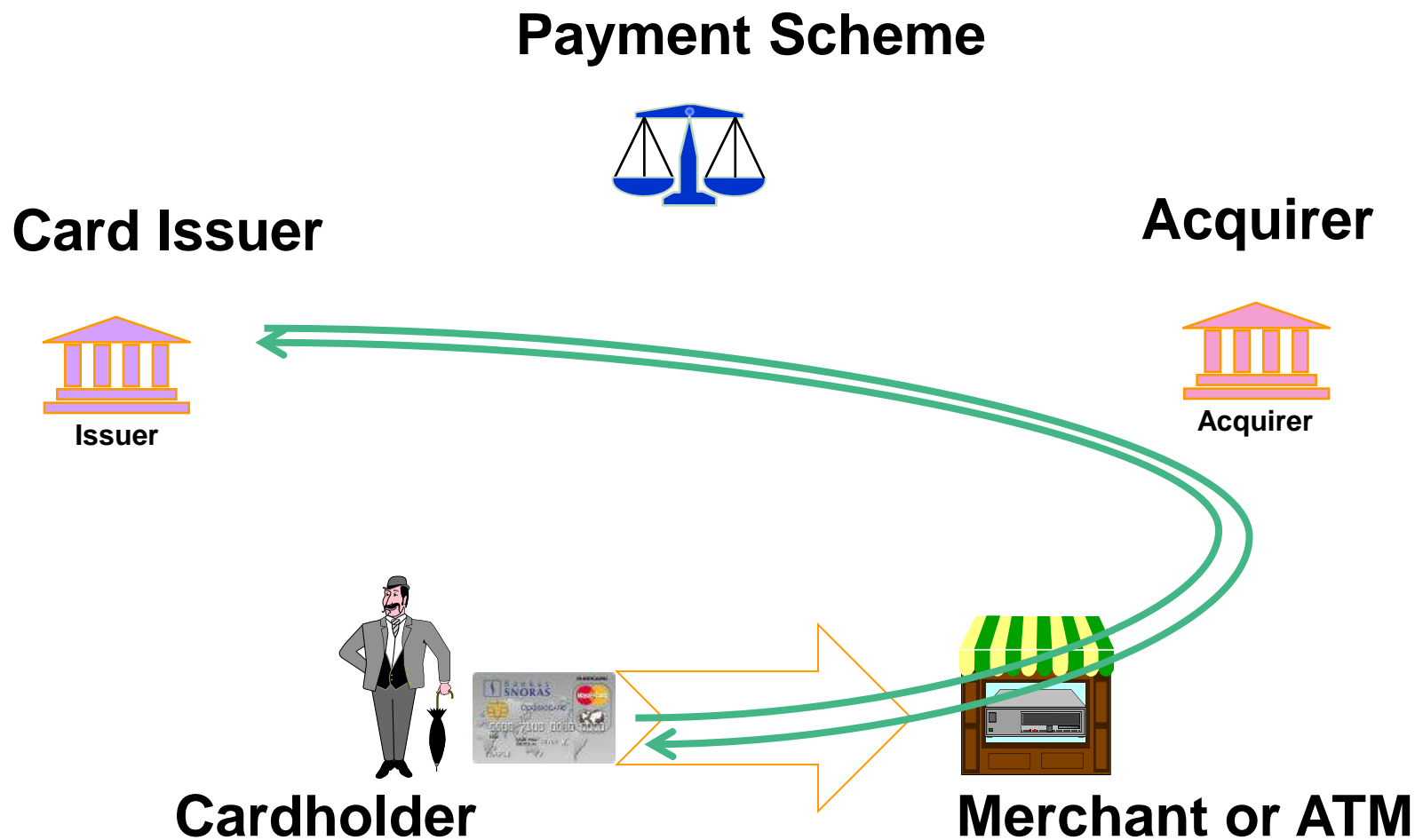
Merchant

- Funds received for release of goods/services
 - Integrity of an authorised transaction
 - Source authentication of authorisation
 - Non repudiation of a properly constructed authorisation
 - Audit and enquiry trail

Financial institution

- Source authentication of the merchant/cardholder
- Non-repudiation by acceptor /cardholder
- Data integrity for both originated and received
- Identification and rejection of counterfeit cards

Card Payments - The Players



Symmetric Cryptography



Cryptograms from card

- ARQC, TC, AAC
- 8 byte MACs on critical transaction data



Response from Issuer

- Issuer authentication by card (4-8 byte cryptograms)
- Secure Messaging: Card block/unblock, PIN Change



EMV recommended key derivation

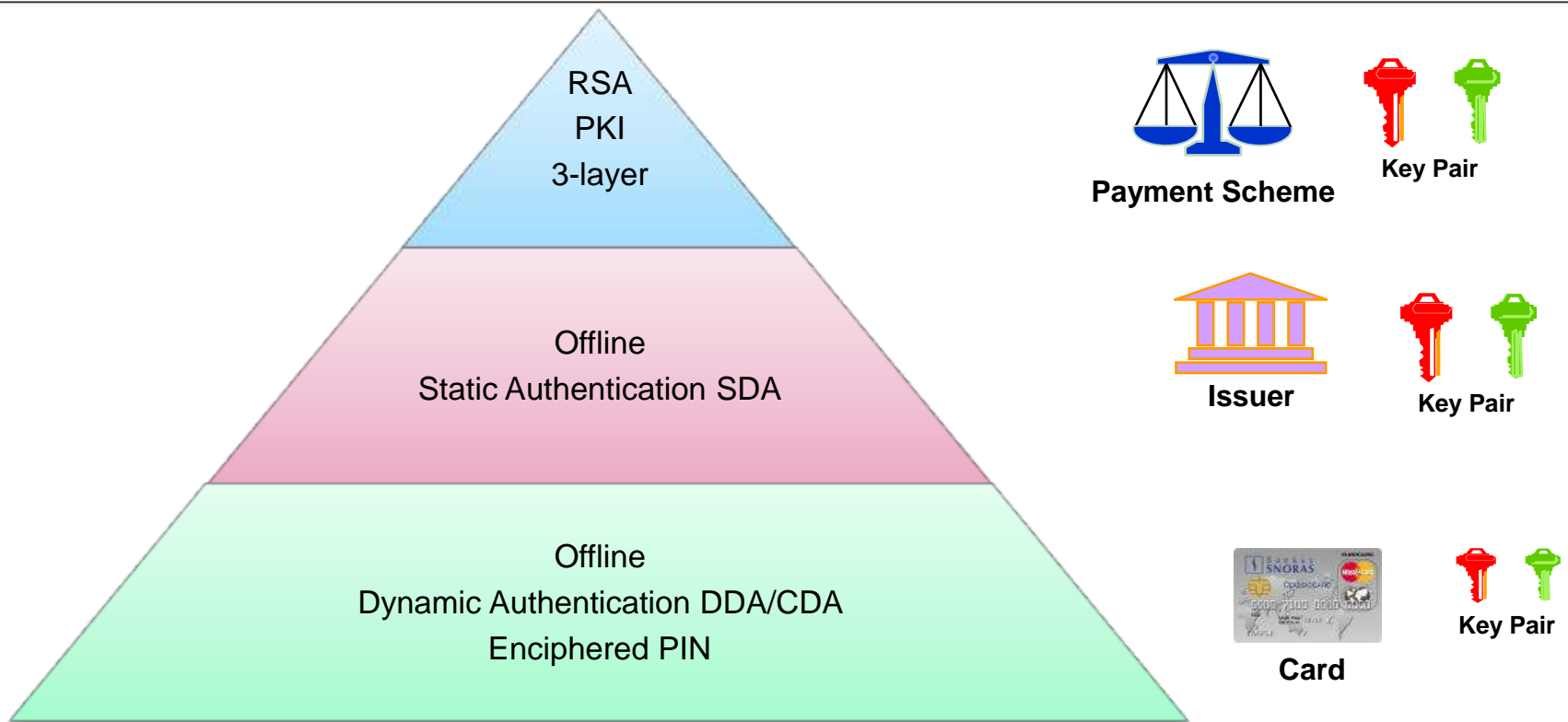
- Card keys derived from Issuer keys using Card Number
- Session keys derived using Transaction Ctr and/or UN



MACs: EMV recommends ISO/IEC 9797-1

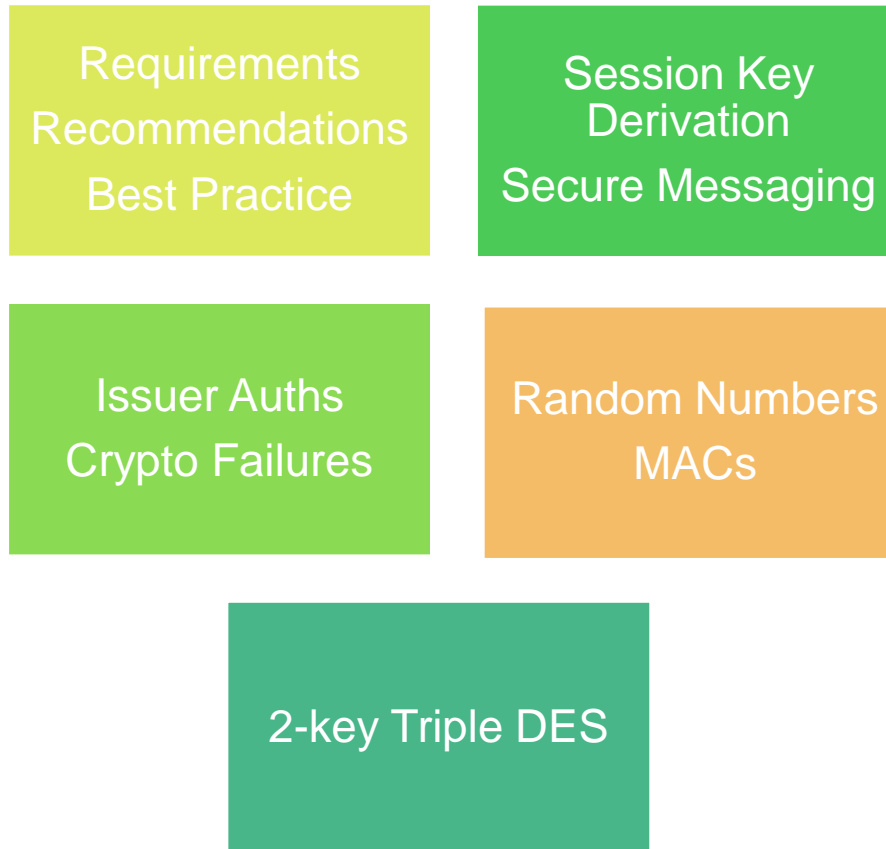
- Algorithm 3 (ANSI Retail MAC with 2-key TDES)
- Algorithm 5 (CMAC with AES-128/192/256)

Asymmetric Cryptography



- ISO/IEC 9796-2: Digital Signature Scheme giving message recovery – Part 2: Integer Factorization based methods (method 1) with SHA-1
- Signature formats and PIN encipherment are EMV proprietary

Experience and Research I



References

Experience and Research II

Payment System
RSA key lengths

768, 896, 1024, 1152,
1408, 1984

Low-exponent

~~$e=2$ Rabin~~

$e = 3$ or 65537



References



References

RSA Signatures
ISO/IEC 9796

$$\sigma = (6A || m_1 || h(m) || BC)^d \bmod n$$

CRT
RSA Key Gen

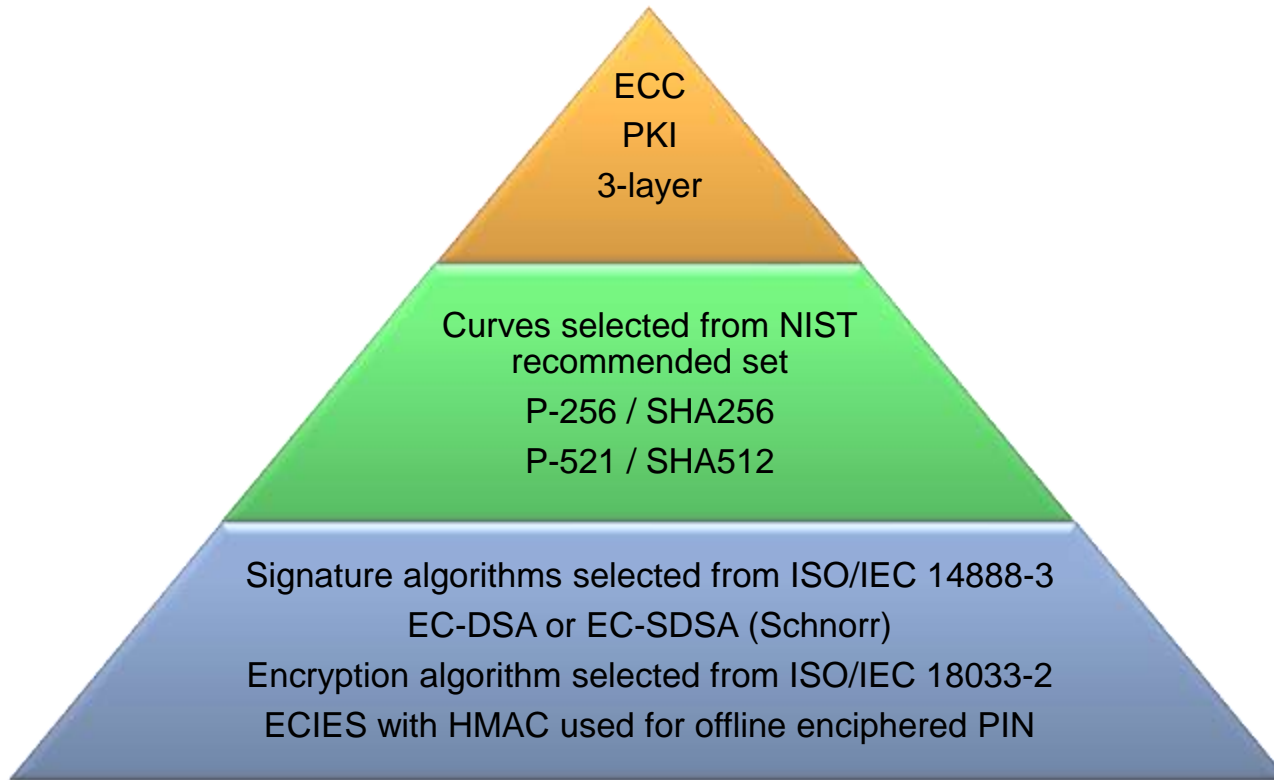
RSA Encryption
Key Separation

$$\text{Enc}(\text{pin}) = (7F || \text{pin} || \text{UNcard} || \text{RANDterminal})^e \bmod n$$



References

Future Asymmetric Cryptography (work in progress)

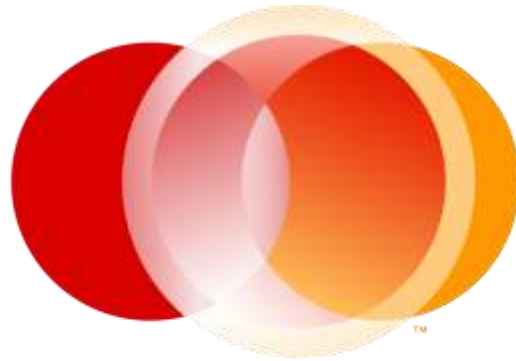


Hash algorithm selected from ISO/IEC 10118

- Defaults are SHA256 (for P-256) and SHA512 (for P-521)
- Considering also SHA3 (due 2012) or AES-based hash



References



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Symmetric Cryptography references

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Original and Next Step references

Original EMV

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