Applying Proxy-Re-Encryption to Payments

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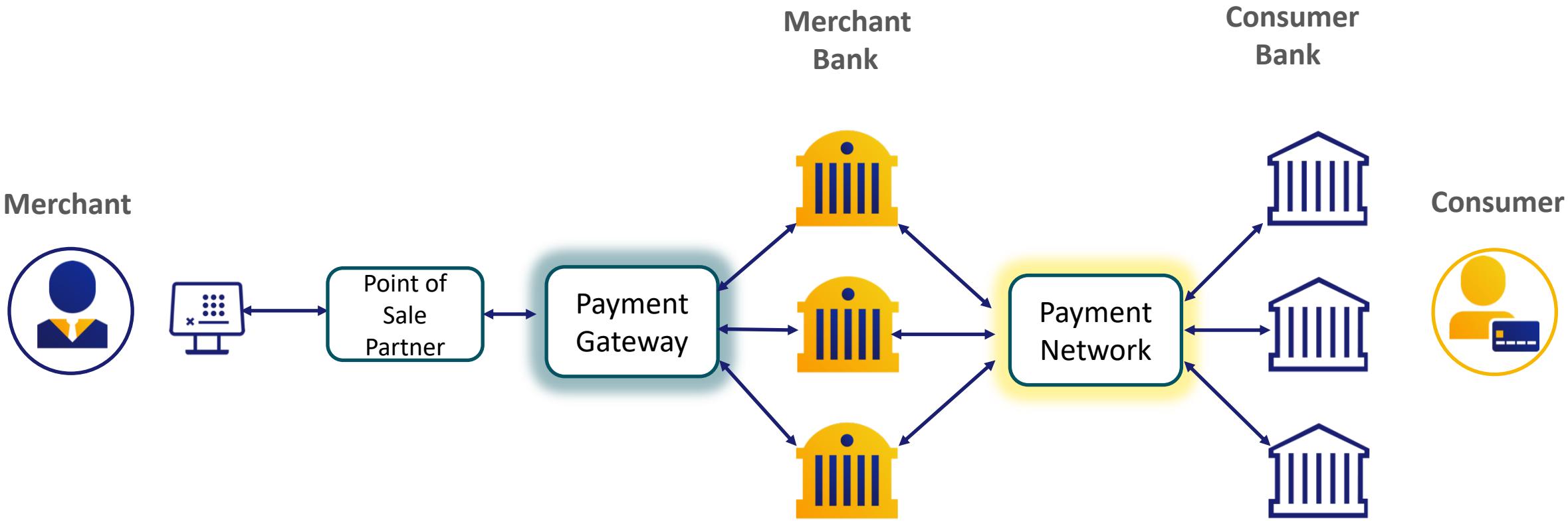
Global Payments Stack



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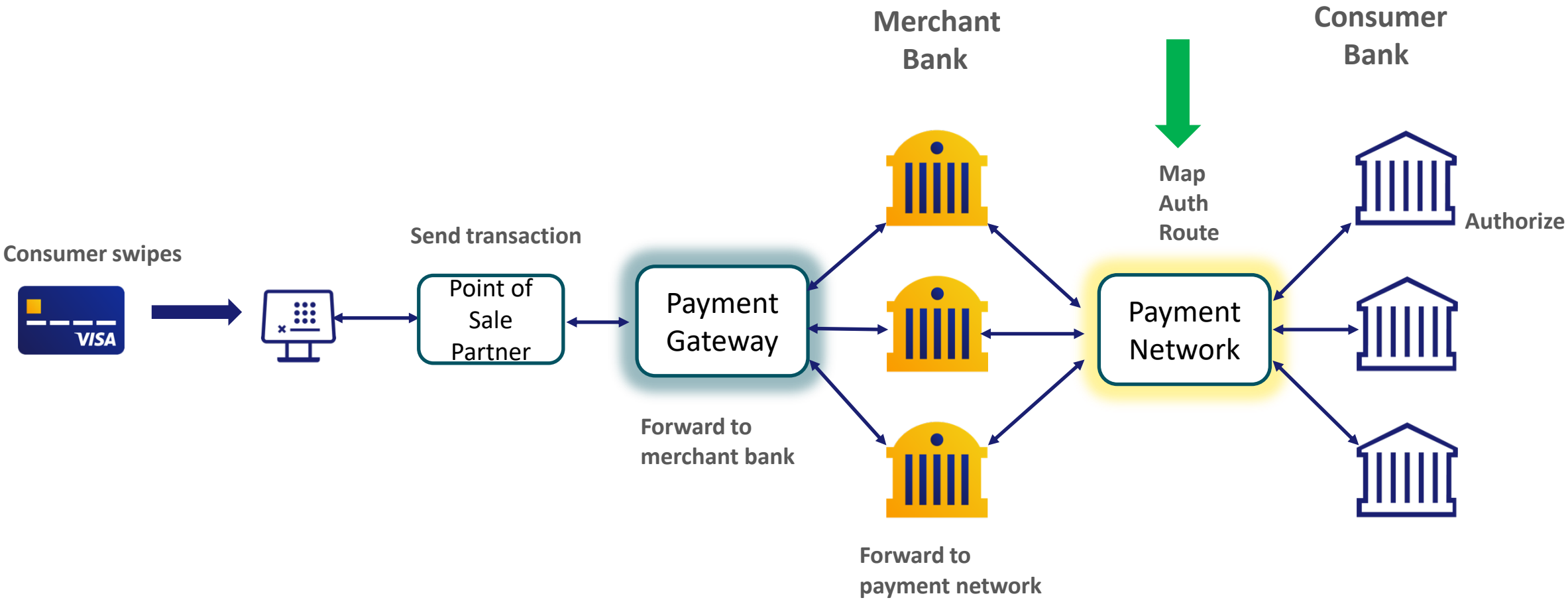
Transaction Flow



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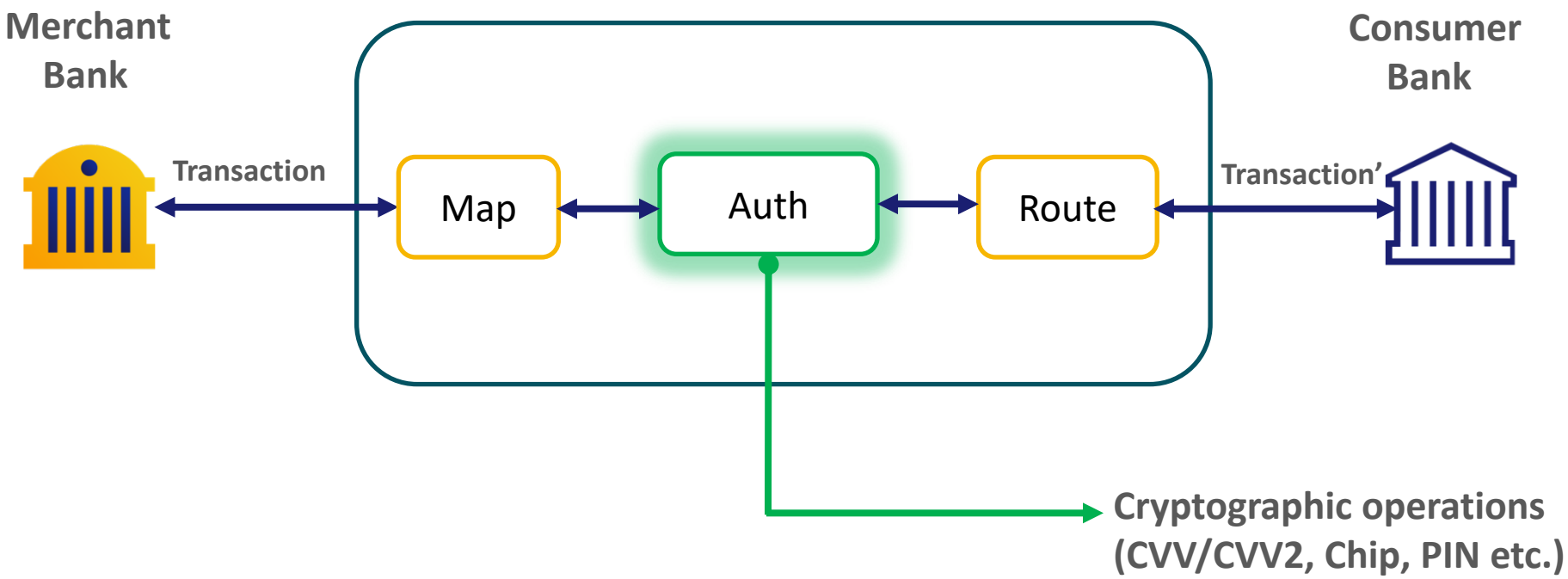
Network Functions



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Sample Transactions

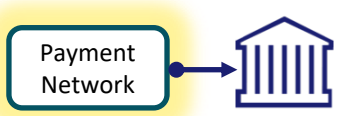
Card Verification Value (CVV/CVV2)

PAN data, CVV → Auth → 1 or 0

Authorization Request Cryptogram (ARQC)

PAN data, ARQC → Auth → 1 or 0

PIN Verification



PAN data, PIN → Auth → 1 or 0

https://www.cs.ru.nl/E.Poll/papers/EMVtechreport.pdf

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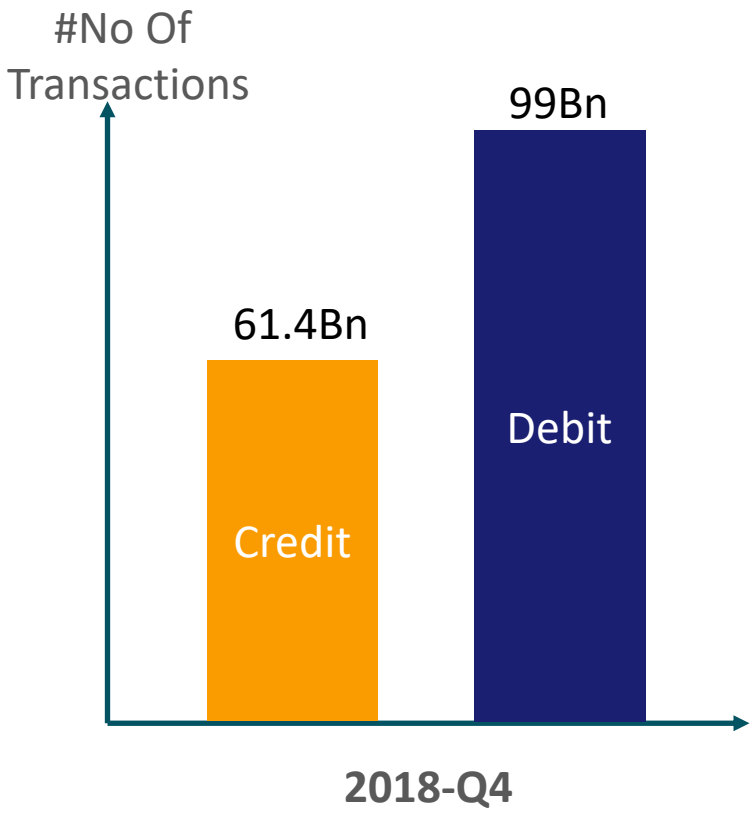
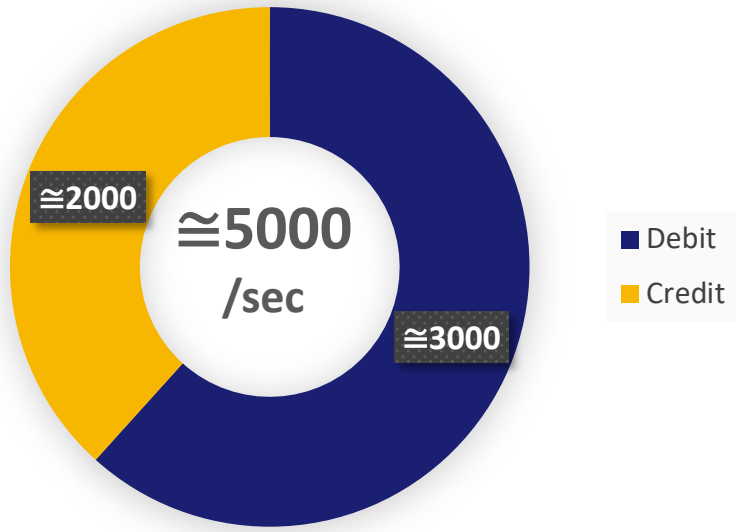
Cryptographic Operations at Scale





https://s1.q4cdn.com/050606653/files/doc_financials/2018/q4/Visa-Inc.-Q4-2018-Operational-Performance-Data.pdf

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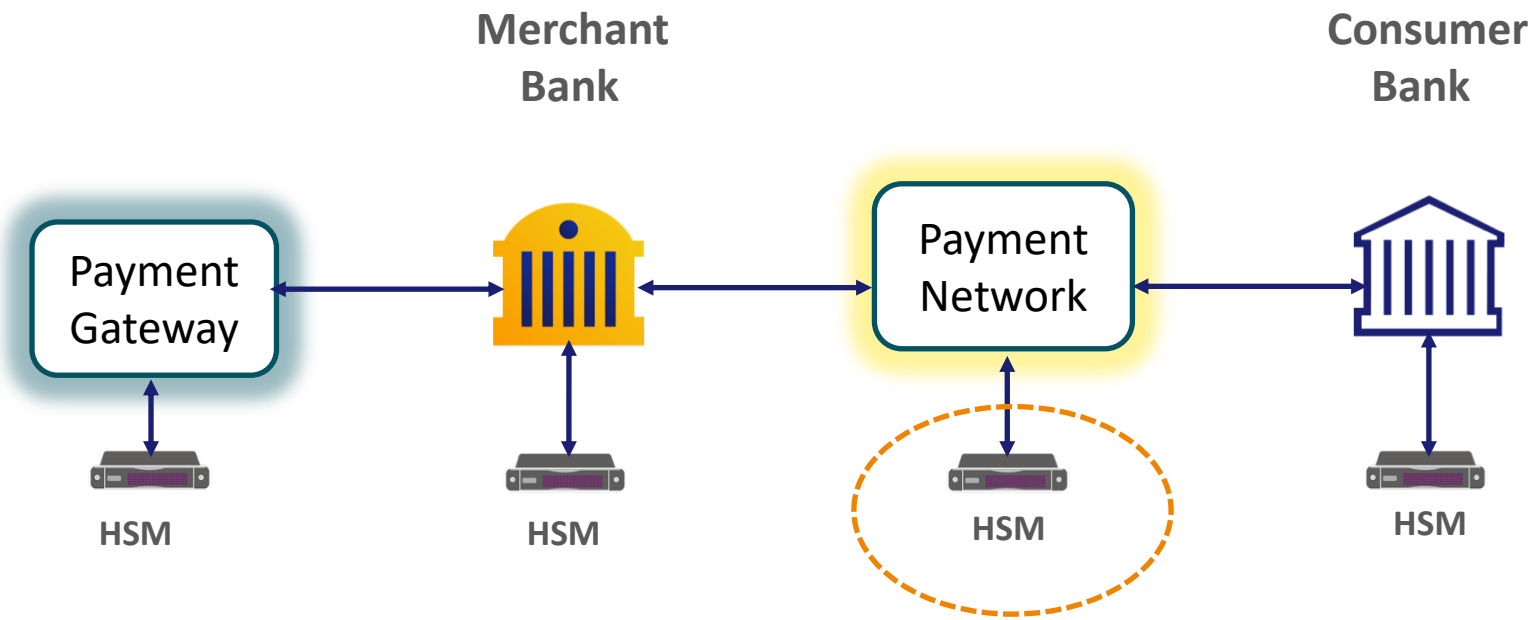
PCI Compliance



https://www.pcisecuritystandards.org/documents/PCI%20HSM%20Security%20Requirements%20v1.0%20final.pdf

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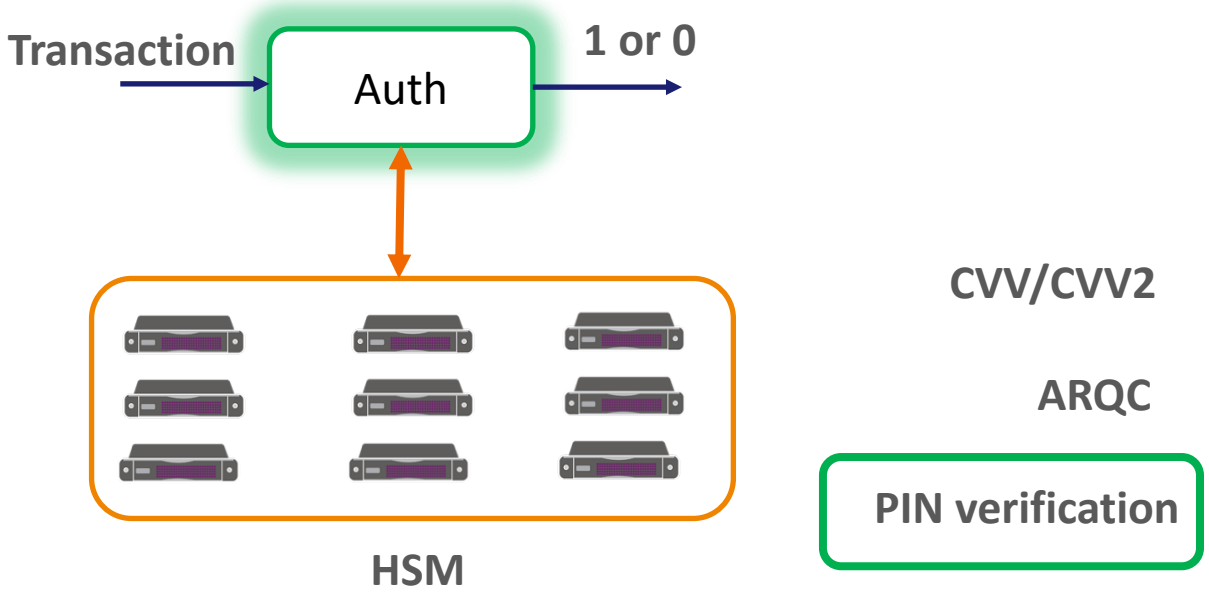
Top Hitters



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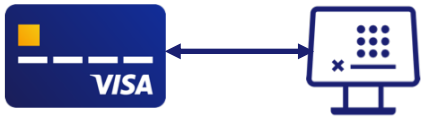
PIN Verification Modes

Consumer
Bank

Online



Offline

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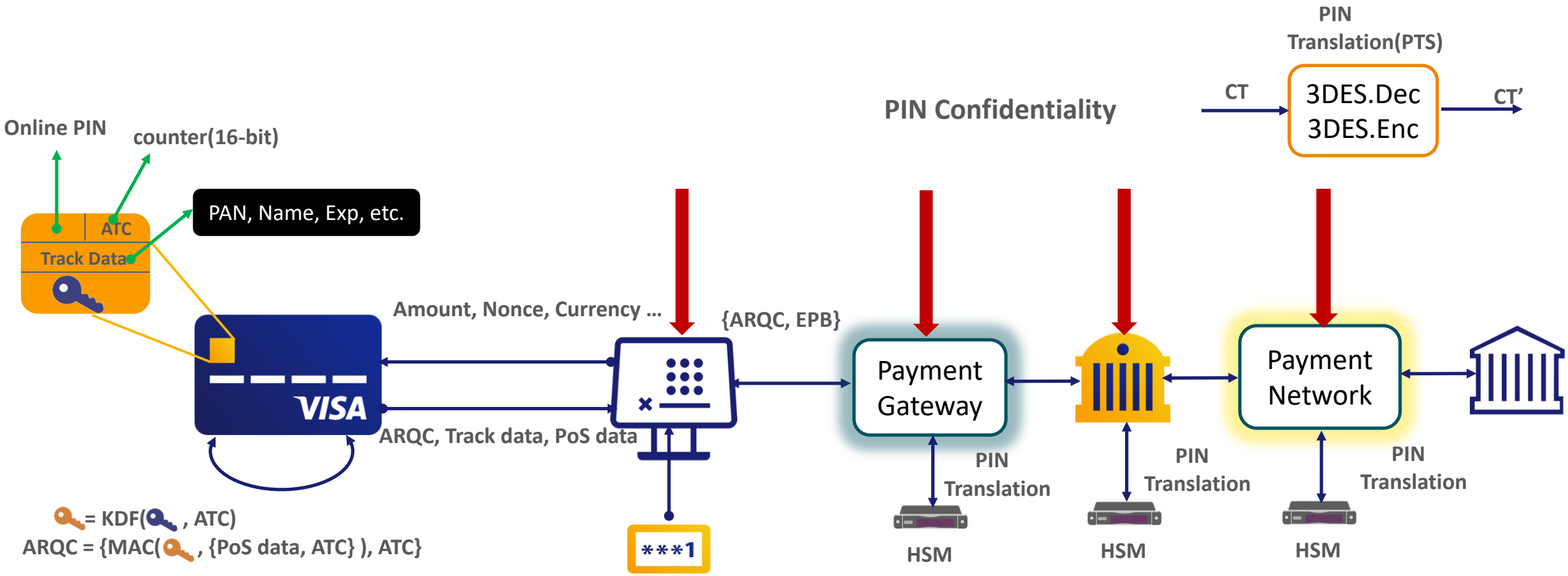
Chip & PIN Transaction



EPB: Encrypted PIN Block

ARQC: Authorization Request Cryptogram

EMV-Book-2_Security And Key Management

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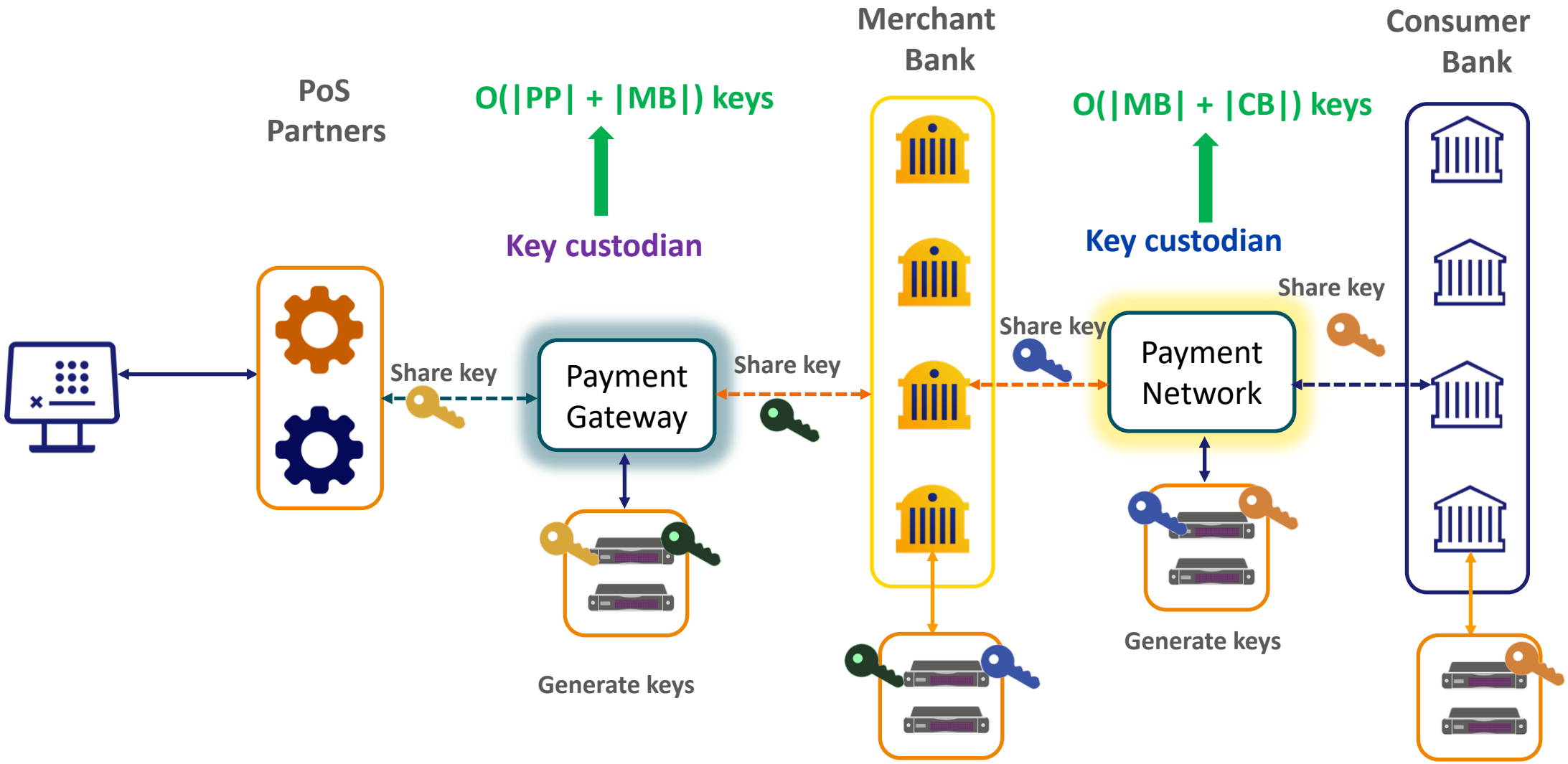
Key Sharing Setup



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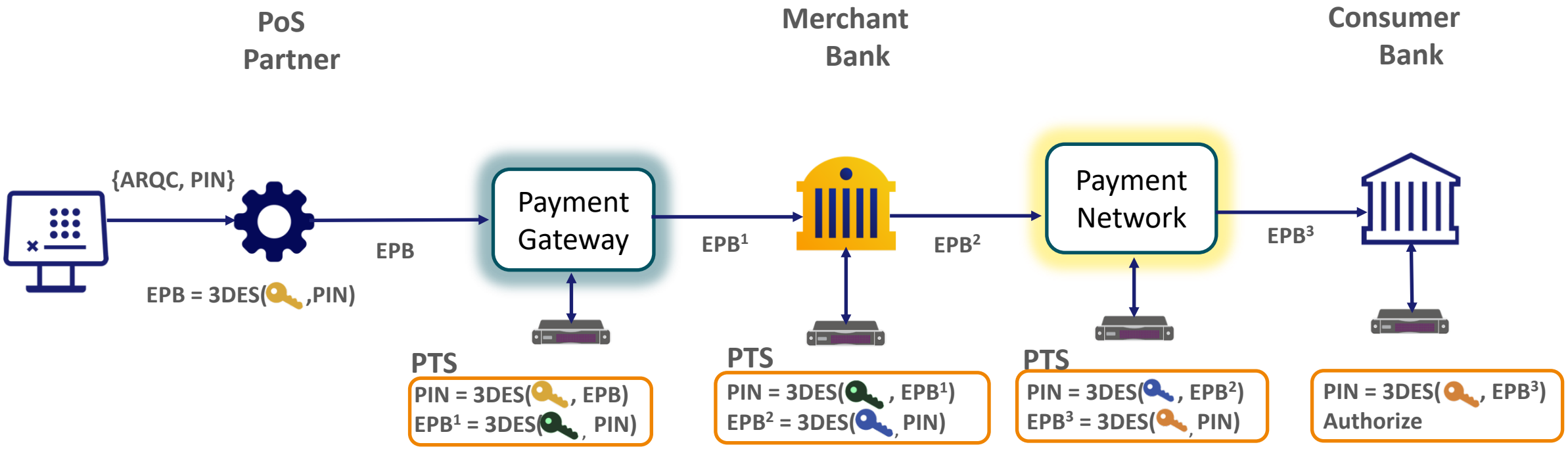
PIN Confidentiality



EPB: Encrypted PIN Block

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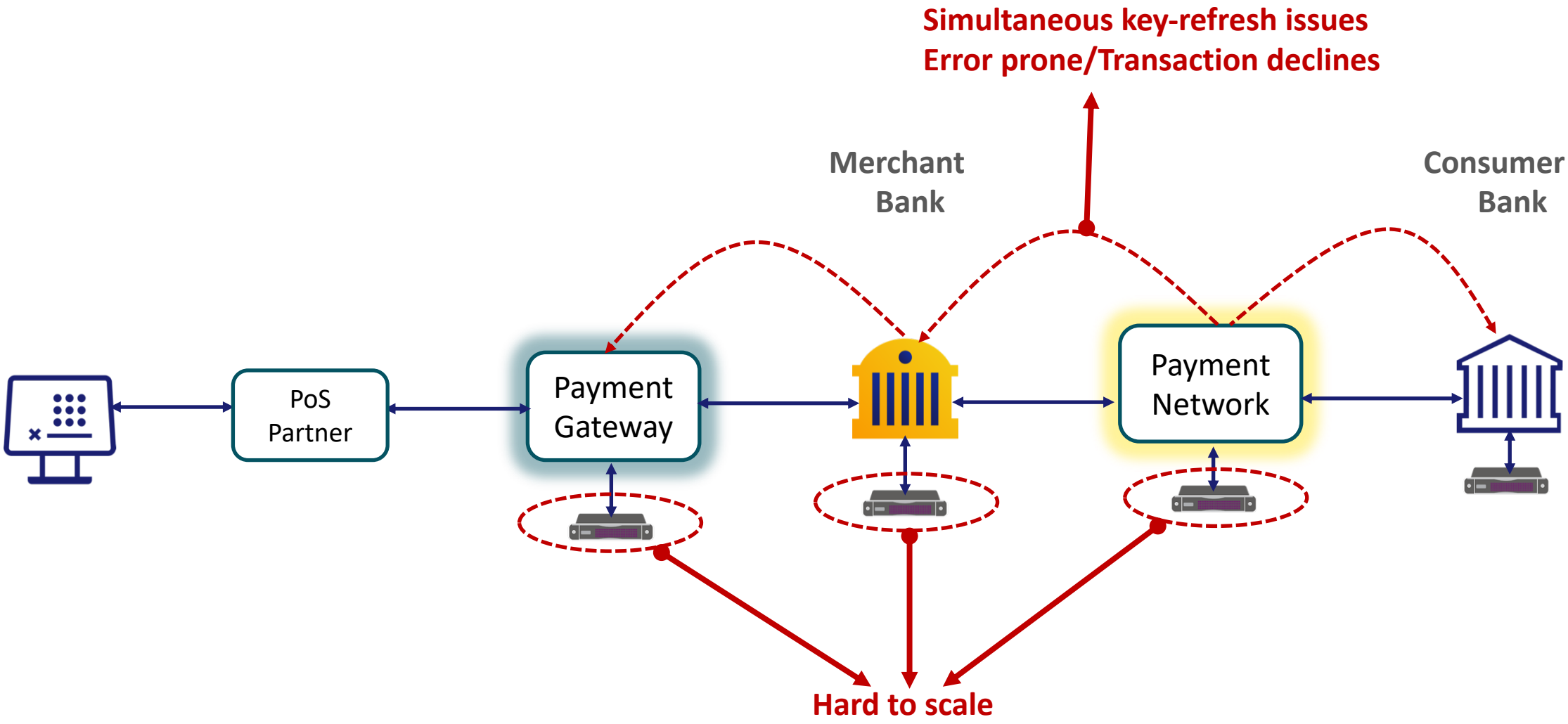
PIN Confidentiality Problem



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Requirements

- ✓ Support for all payment types(chip/mag-stripe, apple pay etc.)
- ✓ Reduce HSM reliance
- ✓ Incur minimal changes to the ecosystem

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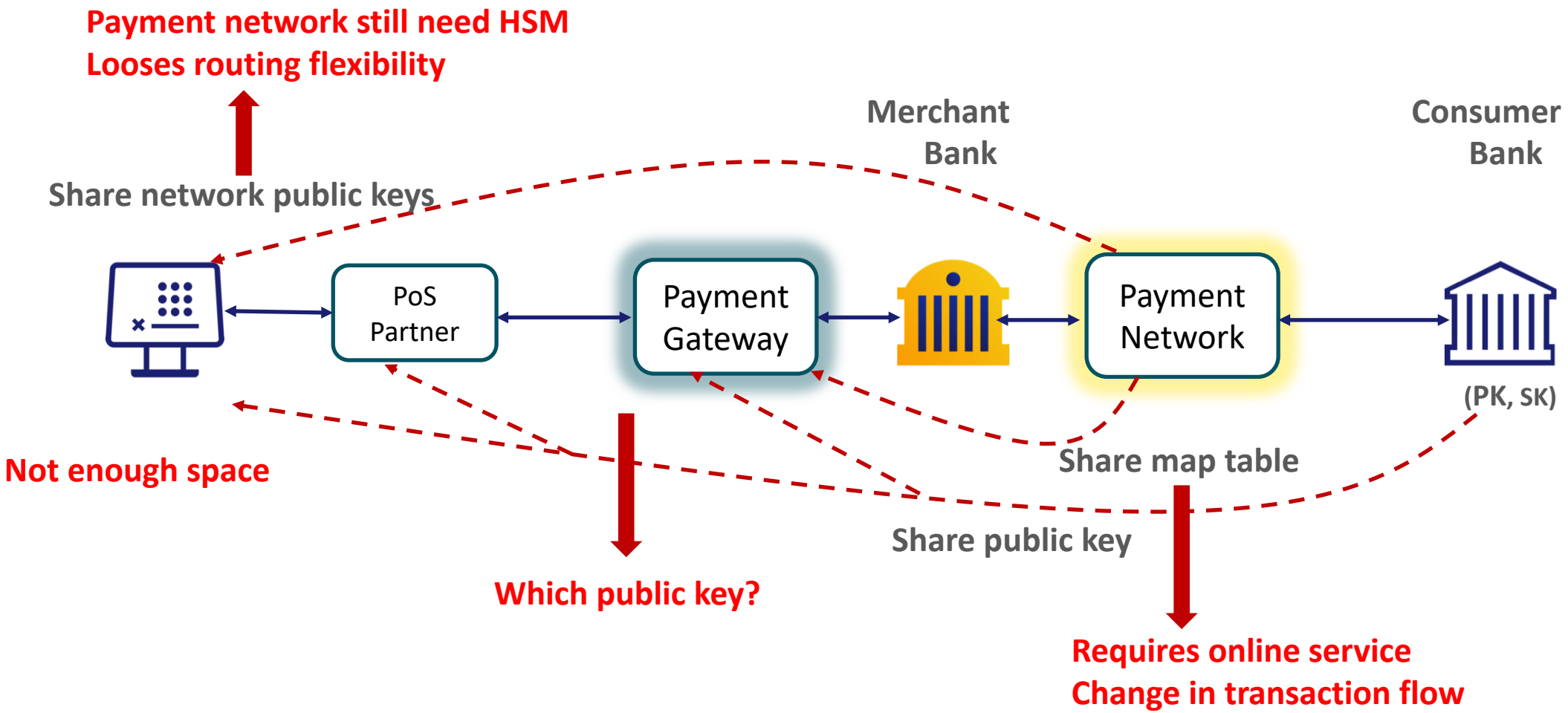
Strawman Solution#1



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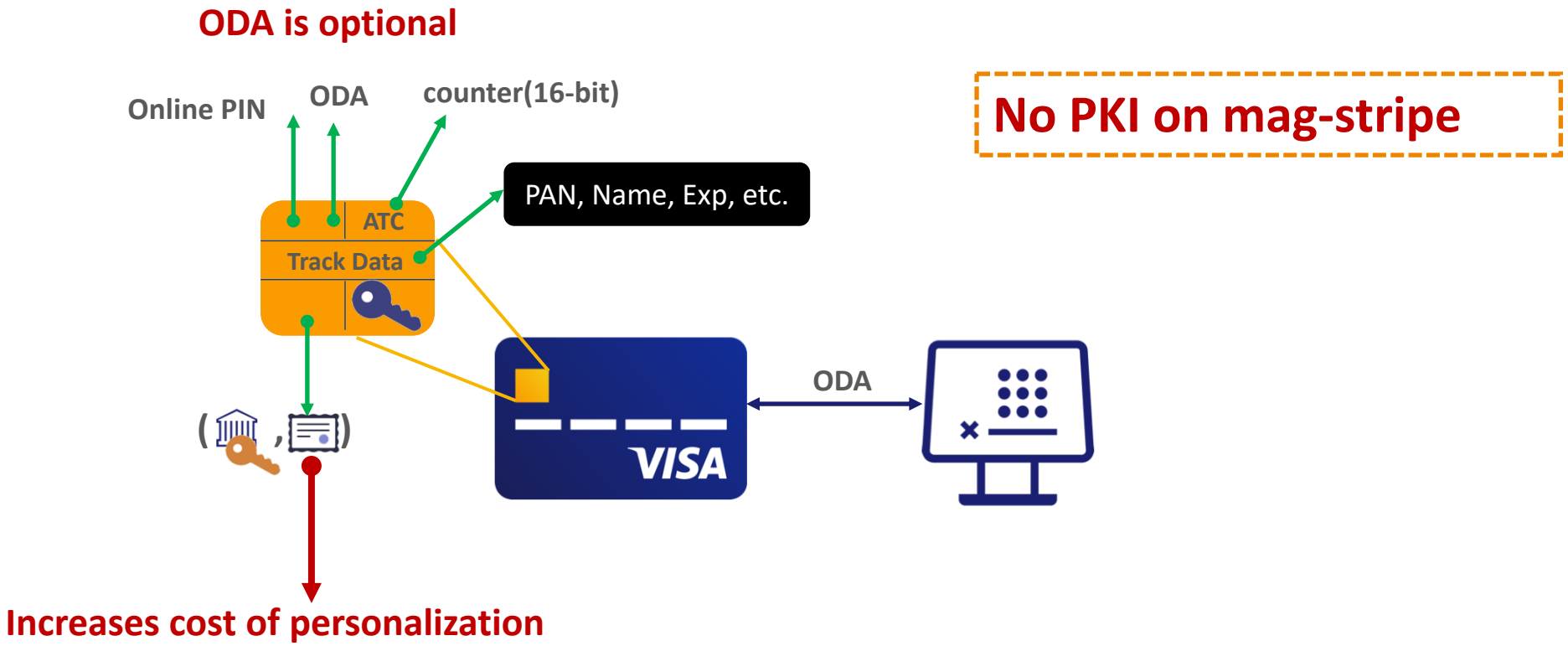
Strawman Solution#2



ODA: Offline Data Authentication

http://www.uspaymentsforum.org/wp-content/uploads/2018/10/Dual-Interface-Card-Personalization-WP-FINAL-Oct-2018.pdf

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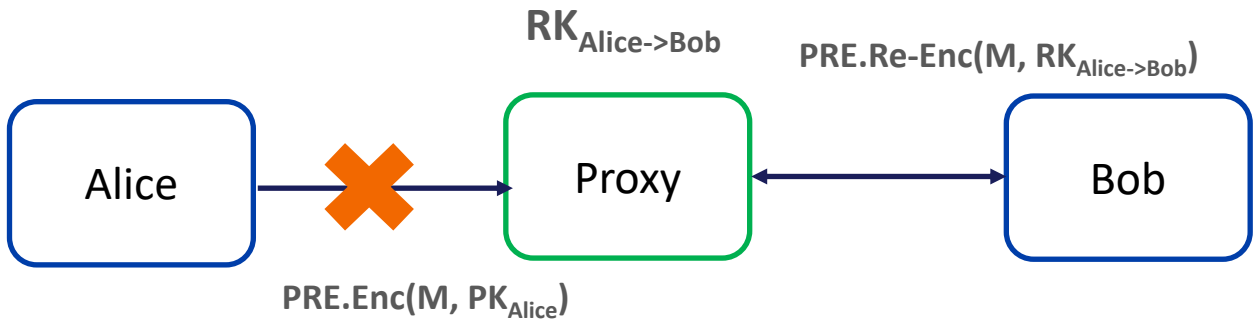
Our Solution: Proxy-Re-Encryption based PIN Confidentiality

PRE

- PRE.KeyGen
- PRE.Enc
- PRE.Dec
- PRE.Re-Key
- PRE.Re-Enc

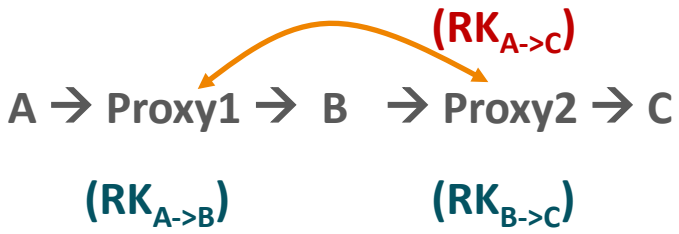


Uni/Bi-Directional

Collusion-Safe

Non-Interactive

Non-Transitive



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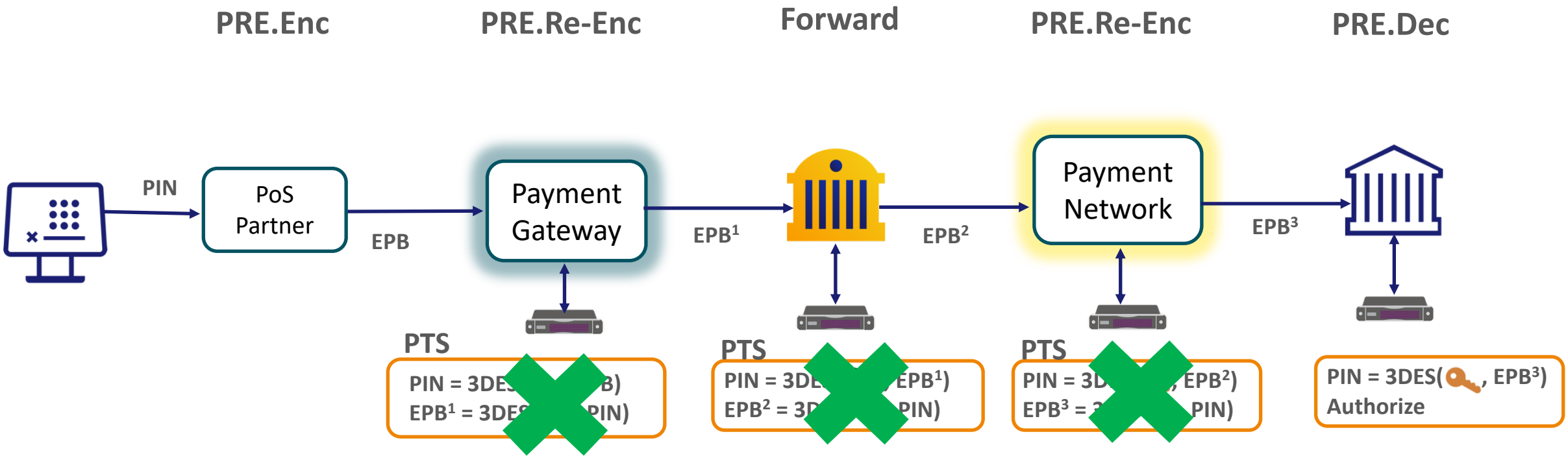
Our Solution: Proxy-Re-Encryption based PIN Confidentiality



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Desired PRE Scheme

Matt Blaze, Gerrit Bleumer, and Martin Strauss. Divertible protocols and atomic proxy cryptography. In Kaisa Nyberg, editor, EUROCRYPT'98

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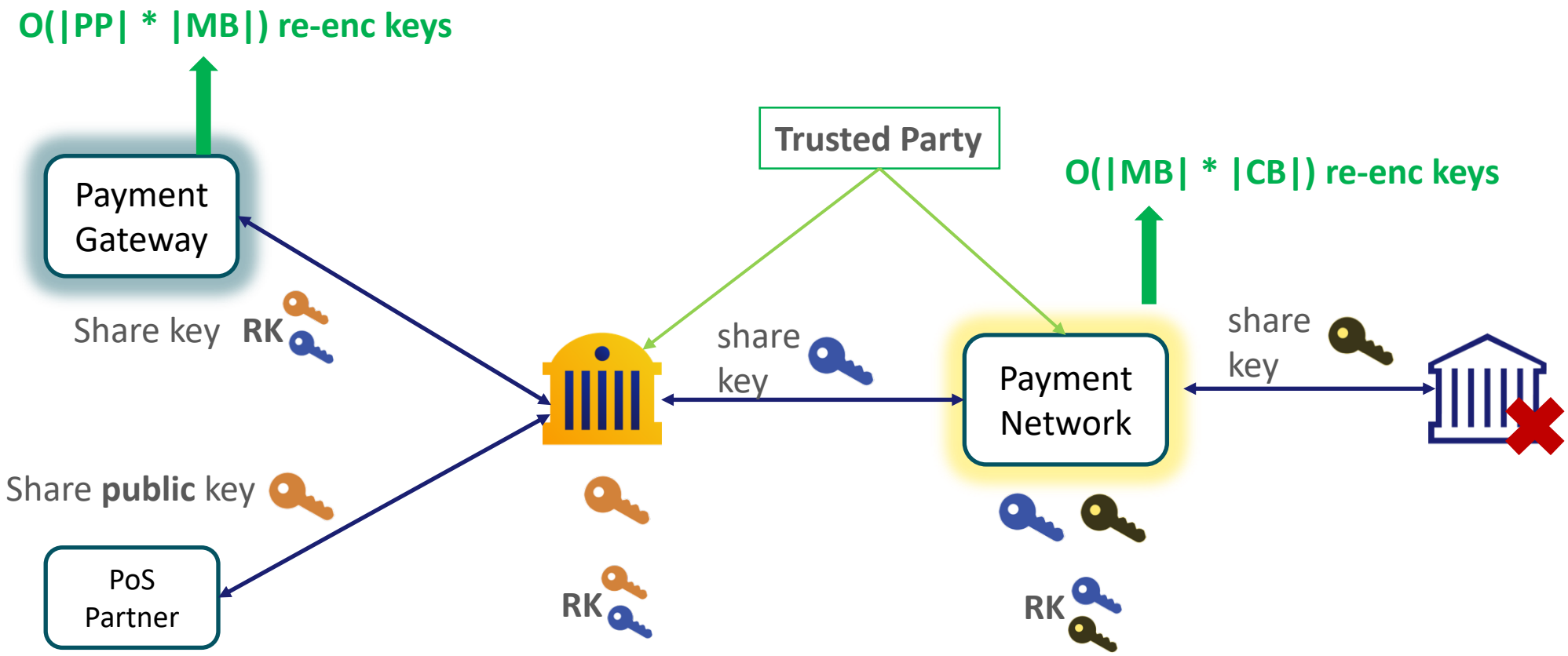
Key Setup



Matt Blaze, Gerrit Bleumer, and Martin Strauss. Divertible protocols and atomic proxy cryptography. In Kaisa Nyberg, editor, EUROCRYPT'98

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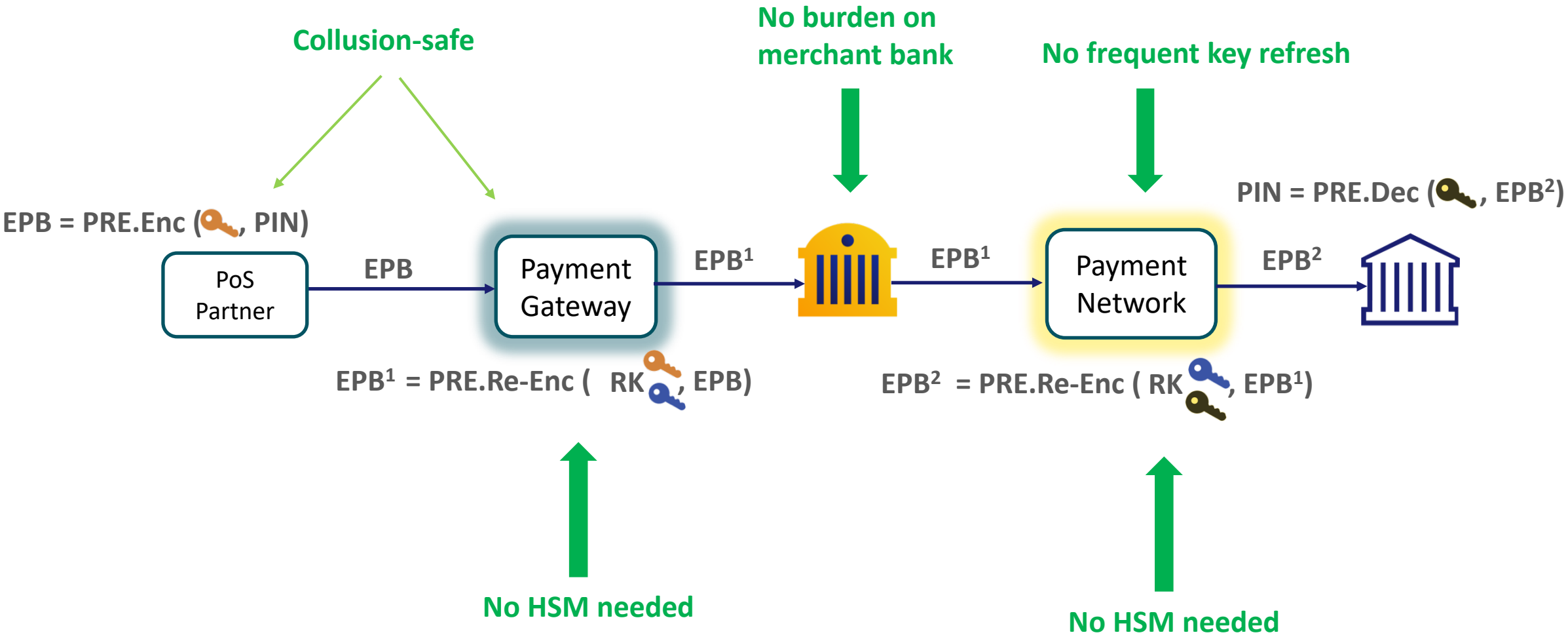
Transaction Flow



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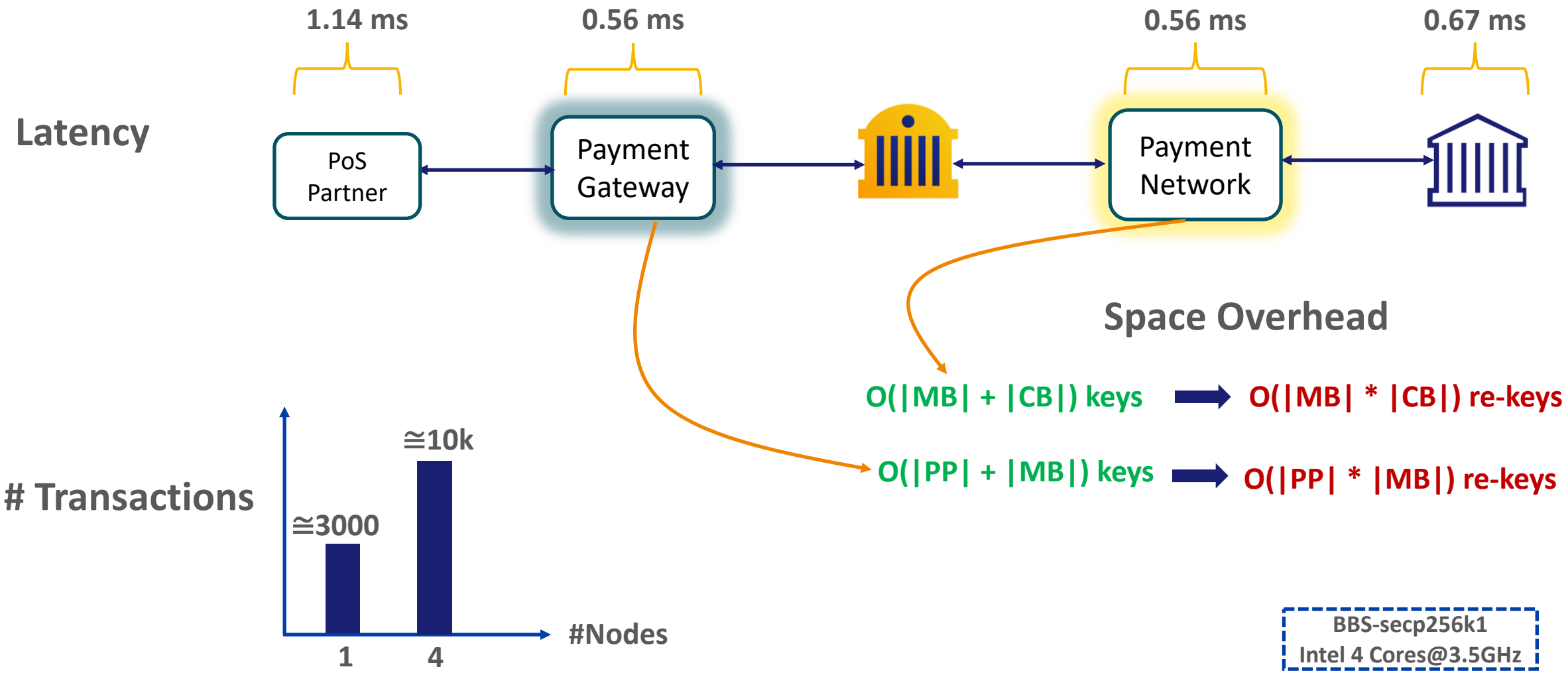
Benchmarks*



BBS-secp256k1
Intel 4 Cores@3.5GHz

* Representative results based on the configuration shown

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Solution Summary

Supports all payment types(chip/mag-stripe, token-based etc..)

Reduced HSM reliance during online phase

Incurs minimal change [Domestic Card Processing Network]

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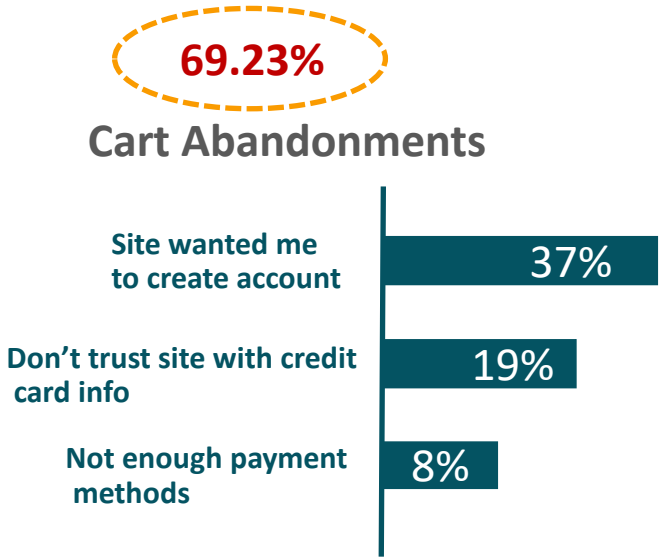
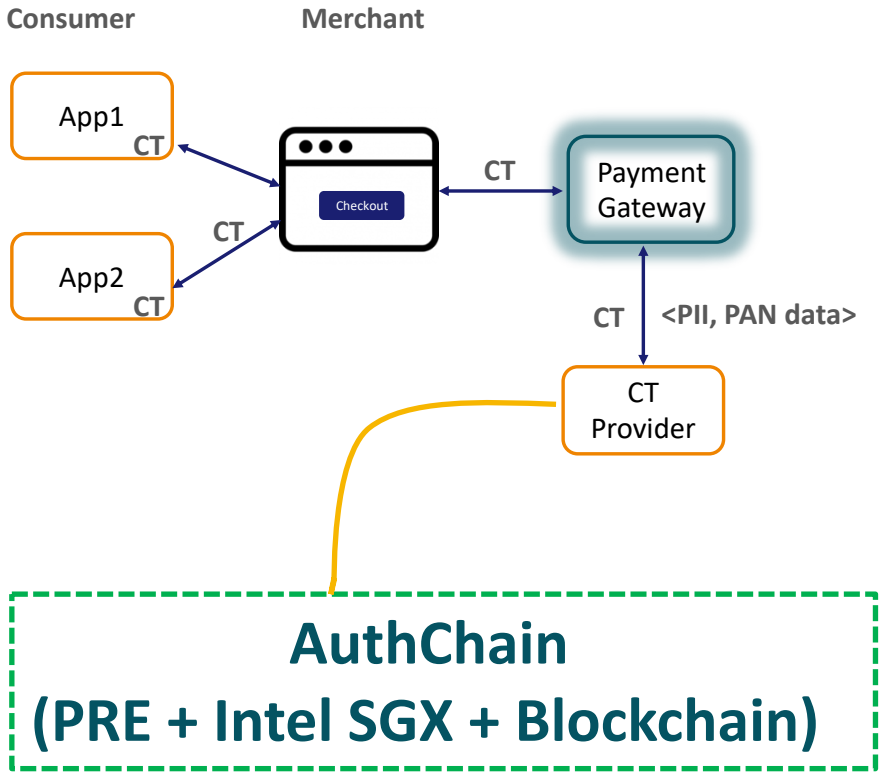
Problem: Cart-Abandonments



Help merchants accept unknown payment types?



https://baymard.com/lists/cart-abandonment-rate
LexisNexis-True-Cost-Of-Fraud-Study, 2017

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Conclusion

PIN Translation: PRE reduces HSM burden on intermediaries

E-Commerce: PRE helps consumers choose any preferred mobile app for checkout

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