

# E-Payment Systems and Cryptocurrency Technologies

<https://course.ie.cuhk.edu.hk/~ftec4004>

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# Mobile Payment Systems: Technologies & Business Landscape

# Acknowledgements

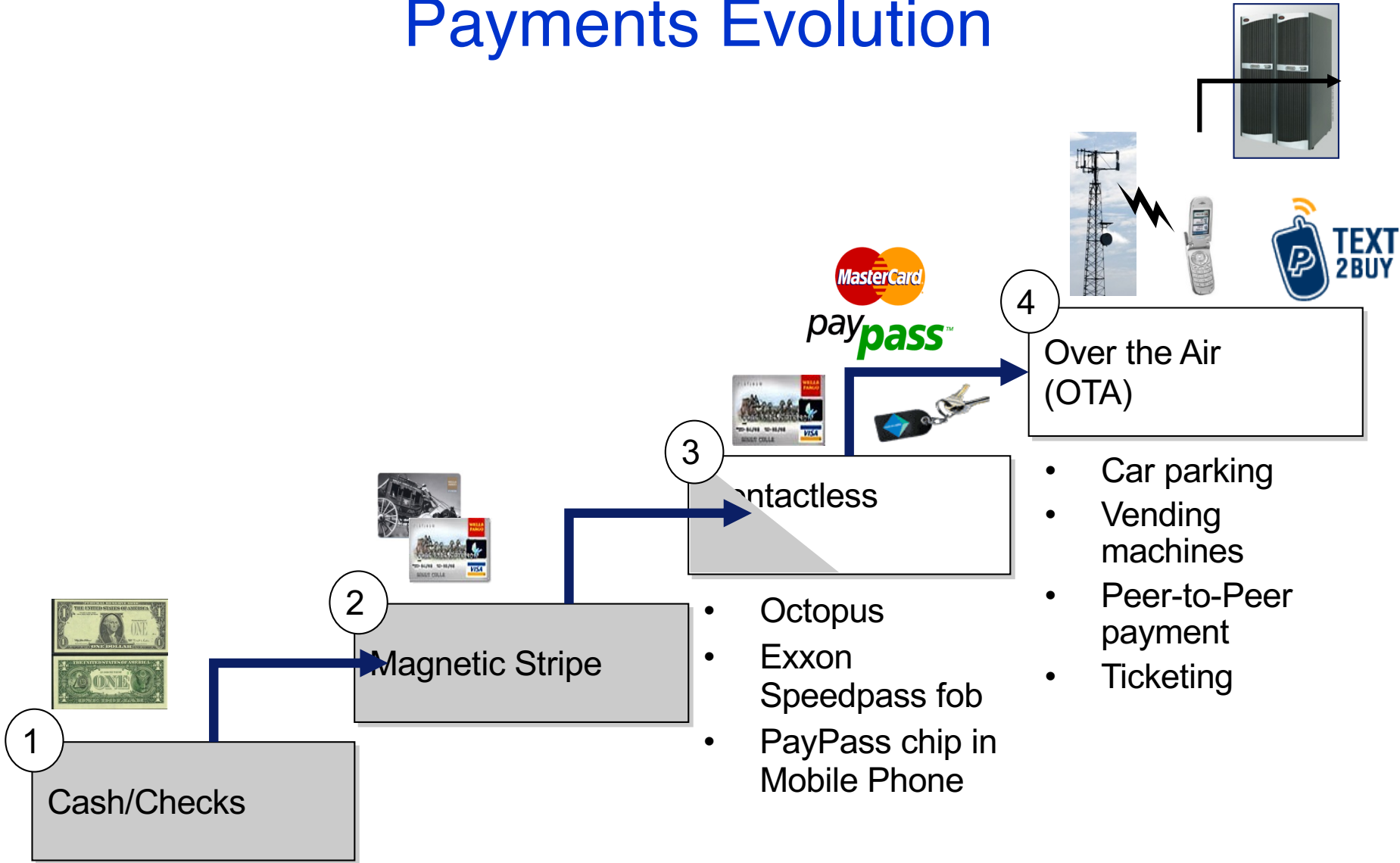
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- The Electronic Payment Systems course by Prof. Michael Shamos, CMU
- “The Changing U.S. Payments Landscape: Impact on Payment Transactions at Physical Stores,” a Smart Card Alliance white paper, Nov 2013.
- Matt Davies, “Hot Topics in Payments,” Federal Reserve Bank of Dallas, Oct 2014
- Leanne Phelps, “EMV, Tokenization and Apple Pay: The New Landscape,” Oct 2014.
- Seth Harrington et al, “What’s NOT in your Wallet ?”, Ropes & Gray, #iLAW Summit, Mar 2015.
- Richard Martin, “Secure Mobile Payments: getting the balance right, “ Sept 2013.
- Nguroho Gito, “Card Payment: Overview of Evolutions, Technology and Business”, IBM, 2018.
- Biometric Payment Cards, Secure Technology Alliance Payment Council, Mar 2019.
- Host Card Emulation (HCE) 101, Secure Technology Alliance Mobile & NFC Council, Aug 2014.
- “Understanding the Role of Host Card Emulation in Mobile Wallets,” Susan Pandey, Marianne Crowe (Federal Reserve Bank of Boston Payment Strategies), Brian Russell May 2016.
- “Is Payment Tokenization Ready for Primetime ?”, M. Crowe et al, June 2015.
- “Mobile Payment – War of Wallets,” Ernest and Young (EY) analysis and interviews, Nov 2015.
- “Security of Mobile Payments and Digital Wallets,” ENISA, Dec 2016.
- Trusted Execution Environment (TEE) 101: A Primer, Secure Technology Alliance, April 2018.
- Enhancing HCE Mobile Payments with TEEs, Dejamobile White Paper, Jan 2019.
- Samsung Pay Security, SAMSUNG, <https://www.bada.com/tech-insights/pay#> retrieved on Mar 2020.
- NFC Mobile Payment, HKMA Financial Infrastructure Dept, HKMA Quarterly Bulletin, Dec 2013.
- Development of Contactless Mobile Payment Services, HKMA Financial Infrastructure Dept, HKMA Quarterly Bulletin, Sep 2012.
- Common QR Code Specification for Retail Payments in Hong Kong – Merchant-Presented Mode, Version 1.0, Dec 2017.
- Digital Mobile Payments – An Industry Influence Study, Appionions, Mar 2014.
- WeChat Impact Report 2016, (CAICT) WALKTEHCHAT, Mar 2016
- Aaron Klein, “Is China’s new payment system the future ?”, The Brookings Institution, Jun 2019
- “Lessons from a mobile payments revolution”, John Engen, AmericanBanker.com, Apr 2018, <https://www.americanbanker.com/news/why-chinas-mobile-payments-revolution-matters-for-us-bankers#top-of-story-PF4M1nYa>
- “Mobile Payment & Fintech in China,” ChinaConnectEU [chinaconnectforum.com](http://chinaconnectforum.com), Jan 2018.
- “2017 Mobile Payment Usage in China Report,” ChinaTechInsights, Tencent, Ipsos, RDCY, Aug 2017,
- “Digital Cash is here, say goodbye to your wallet,” Brian B, MobileTopUp, Jan 2019, <https://medium.com/mobiletopup/digital-cash-is-here-say-goodbye-to-your-wallet-ec57b2c48058>

# Outline

- NFC-based Mobile Payment Systems
  - ◆ Secure Element (SE)/ Trust Service Manager (TSM) approach
  - ◆ Host-based Card Emulation (HCE)
- Payment Tokenization
- The Credit-Card Centric Mobile Payment business Model
  - ◆ Apple Pay
  - ◆ Google Pay
  - ◆ Samsung Pay
- Stakeholders and Business Landscape in Mobile Payments
- QR-code based Mobile Payment Technologies
- The Non-Credit-card-based Mobile Payment Business Model
  - ◆ The Mainland China Story: The Rise of Chinese Super Apps
  - ◆ Alipay, WeChatPay and UnionPay
- Worldwide Landscape of Mobile Digital Wallets
- Technologies for Mobile Point-of-Sale (POS) Terminals

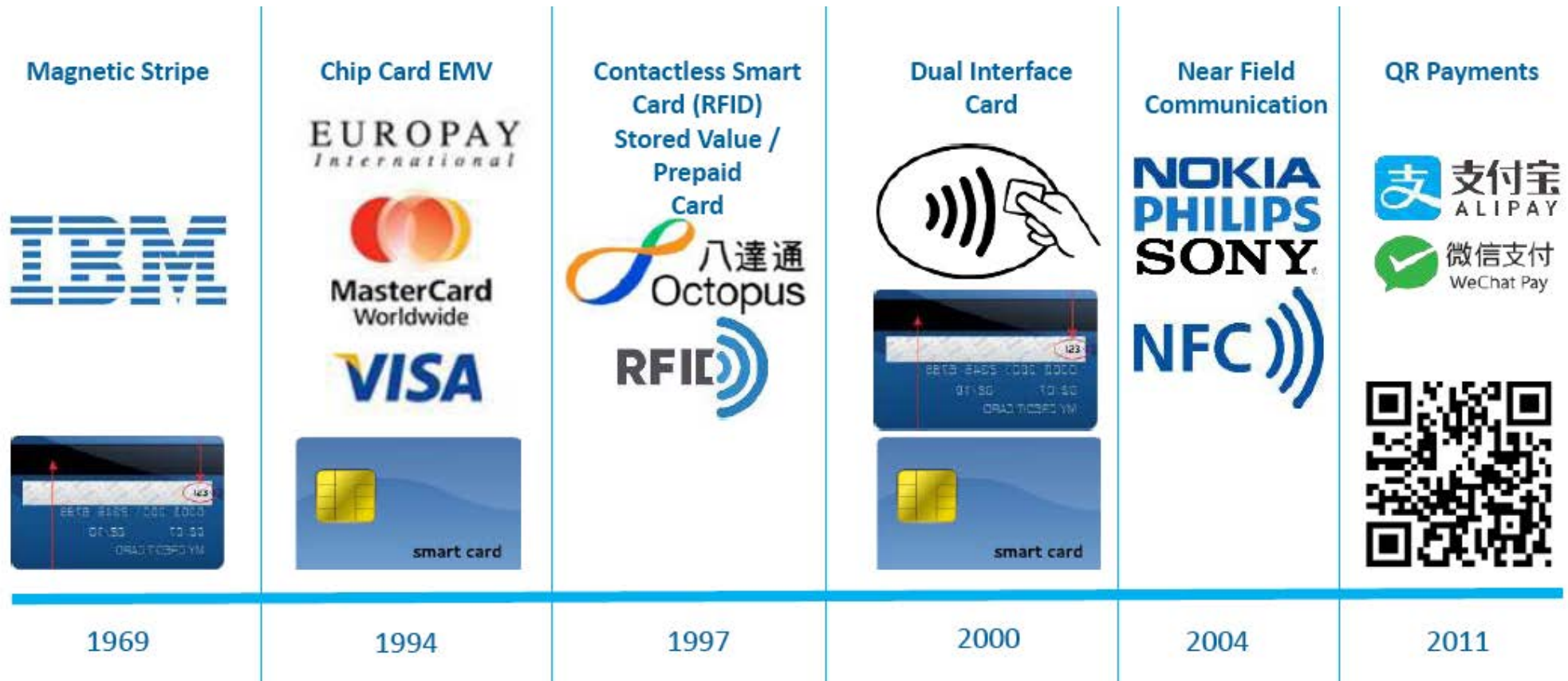
# Payments Evolution



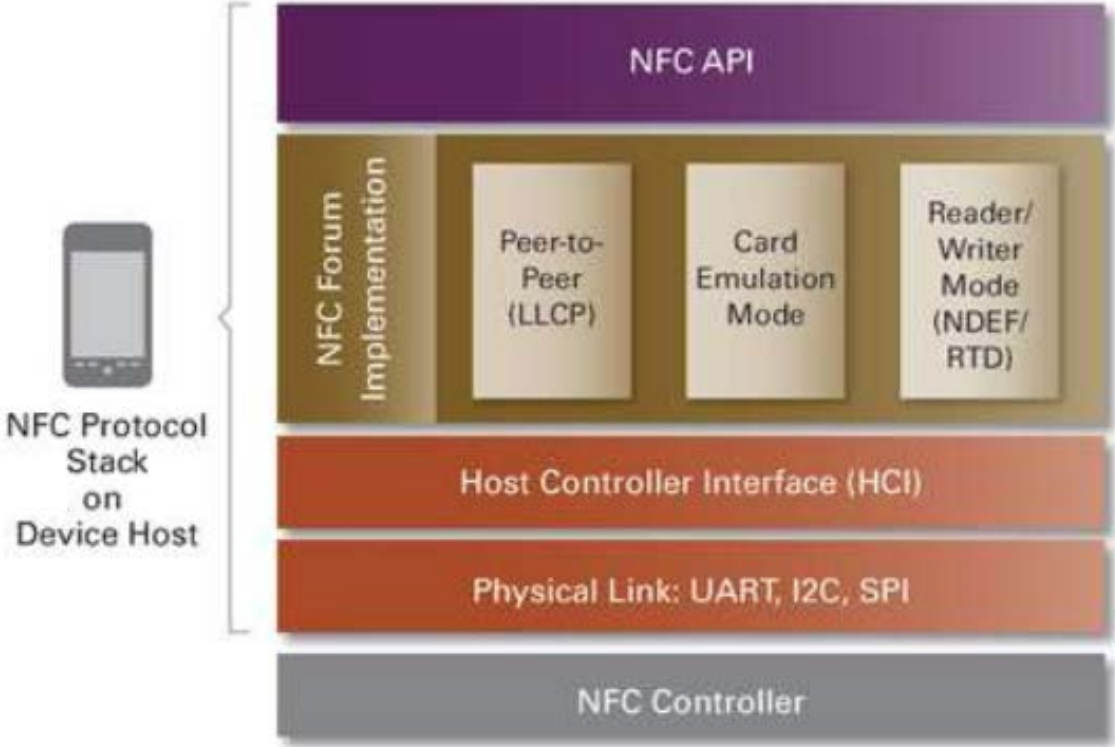
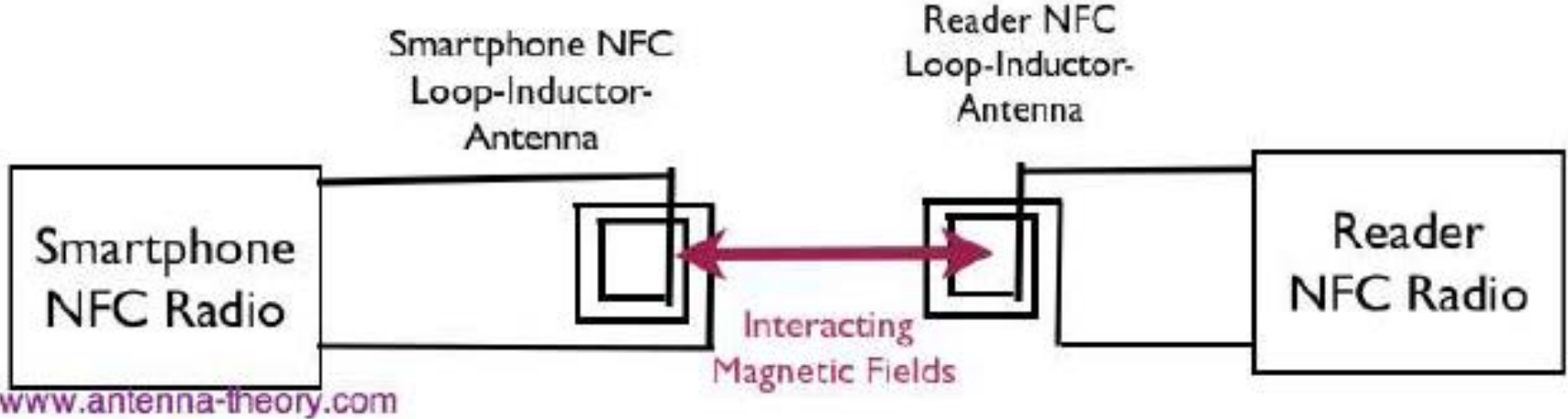
- Car parking
- Vending machines
- Peer-to-Peer payment
- Ticketing

SOURCE: BOOZ ALLEN HAMILTON

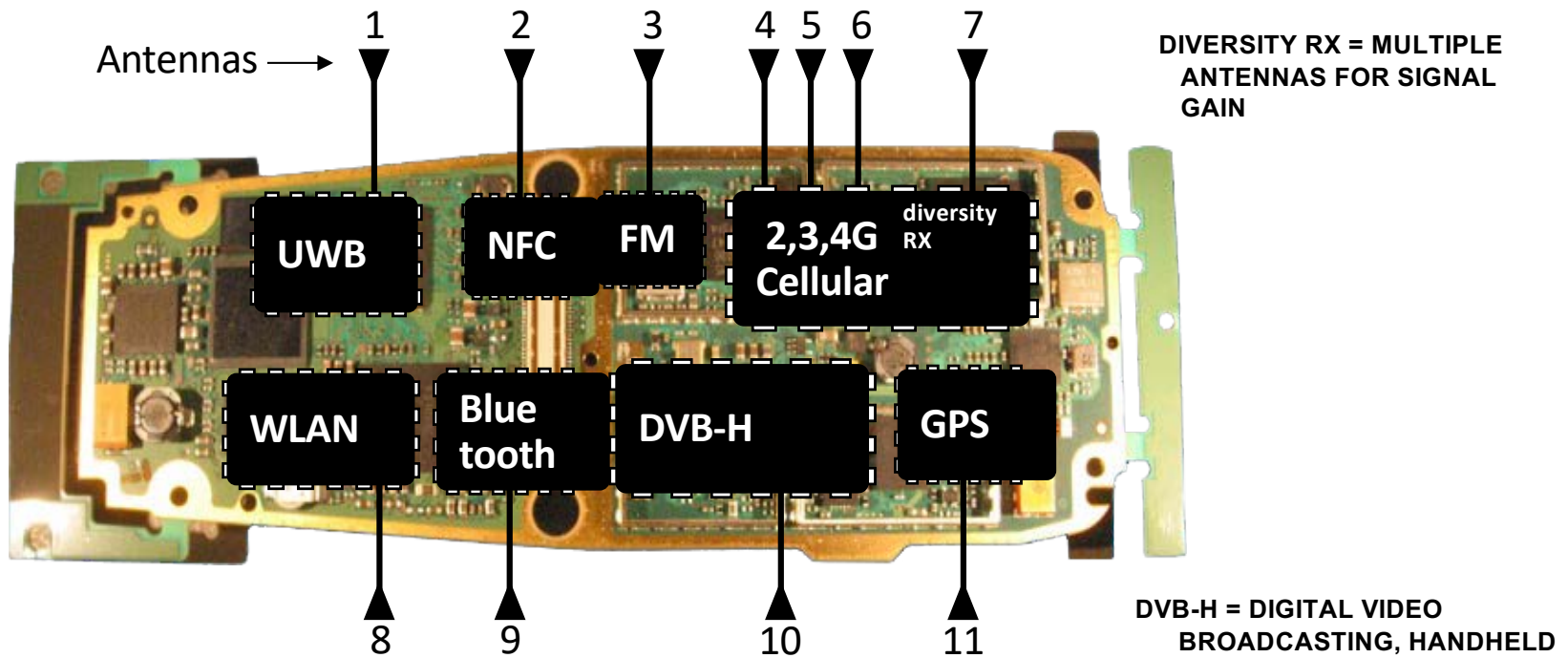
# Payment Media Evolution



# Near Field Communications (NFC)



# Smartphone Support for Seamless Shopping



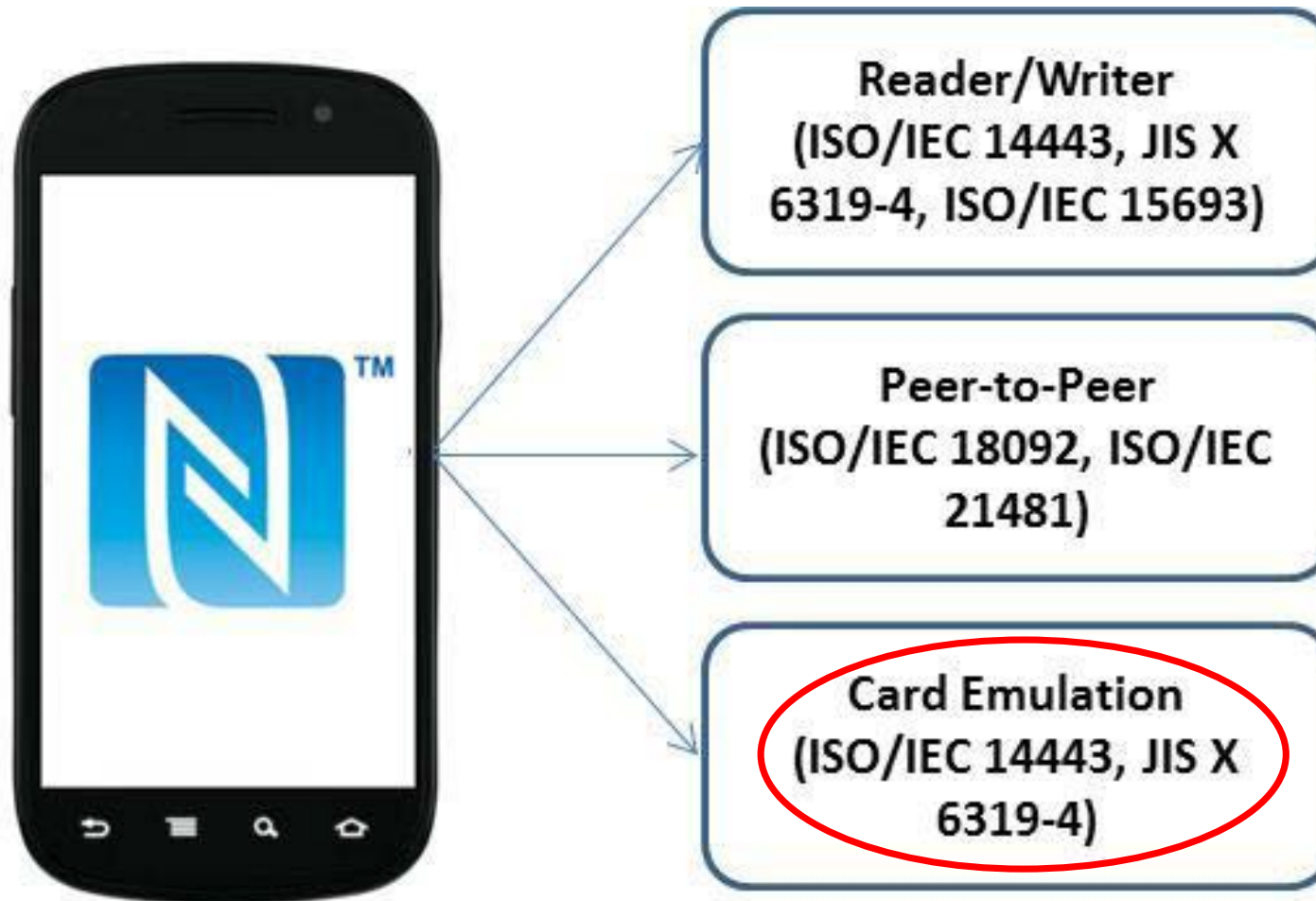
2G/3G/4G together with

- NFC, UWB, WLAN, RFID, Bluetooth, FM Radio, GPS, ...

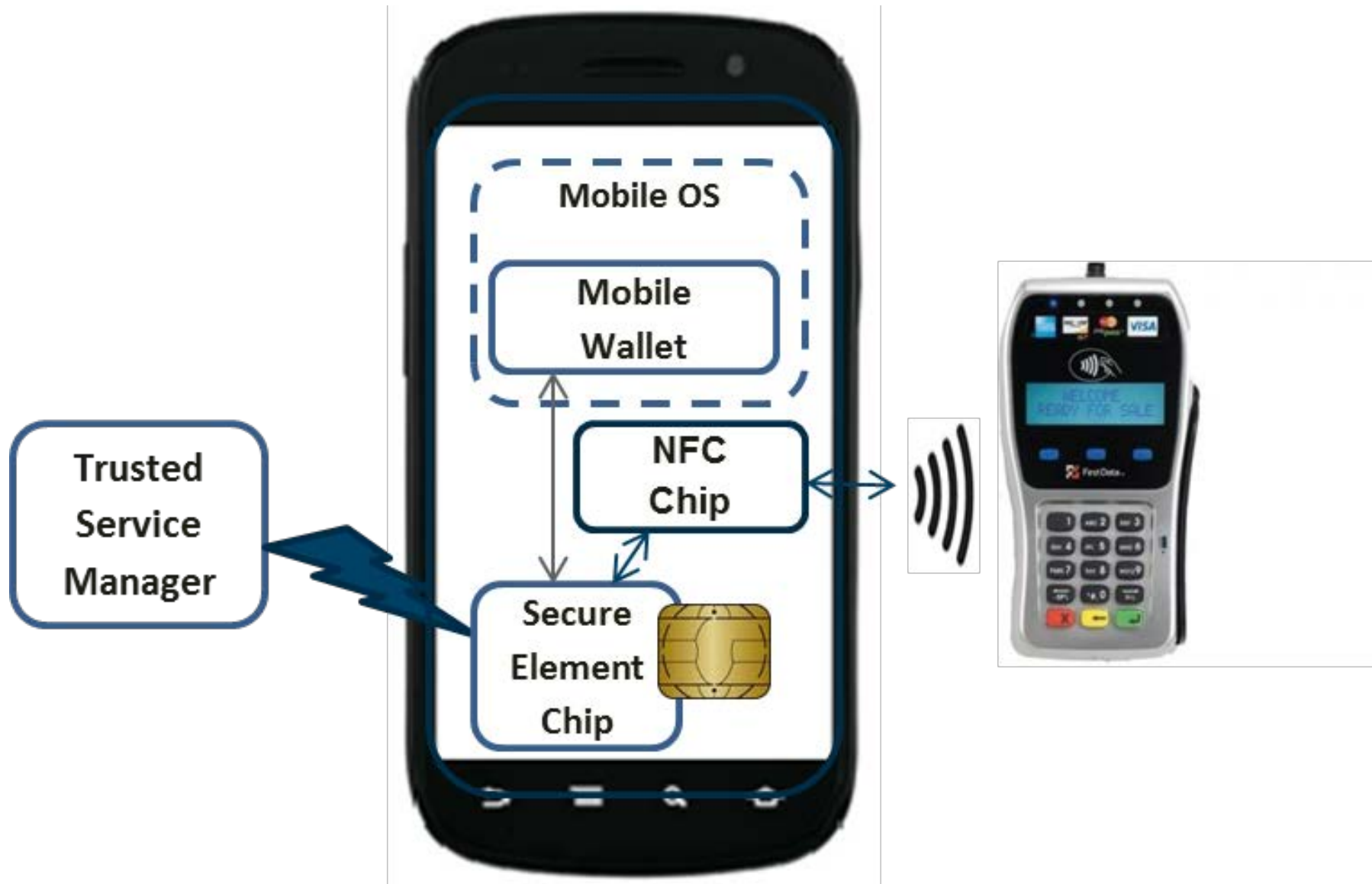
SOURCE: NOKIA



# NFC Operating Modes



# Secure Element (SE)-based Card Emulation



## Before Host Card Emulation (HCE) for NFC

- Before HCE functionalities become available, Android-powered devices that offered NFC functionalities support NFC “Payment Card” emulation by using a separate chip, aka the Secure Element (SE) in the device to emulate the “Payment Card”.
- Such physical SE can be in form of:
  - ◆ an embedded Secure Smart Card IC Chip on the mobile device, or
  - ◆ a Secure microSD card inserted into the phone or
  - ◆ part of the SIM (Subscriber Identity Module) card of the device or
  - ◆ a Universal Integrated Circuit Card (UICC)

Which parties are in control of the ecosystem then ?

- UICCs and SIMs are issued by the Mobile Network Operators (MNOs)
- Embedded SEs are issued by the Mobile Device Manufacturers
- SEs on microSD cards can be issue by any Application provider.

# Secure Elements (SE)

A smart card chip that stores information, manages security and provides a firewall between NFC applications and other elements in the phone. It is installed in one of three ways:

**1** SIM/UICC cards

**2** Micro SD cards



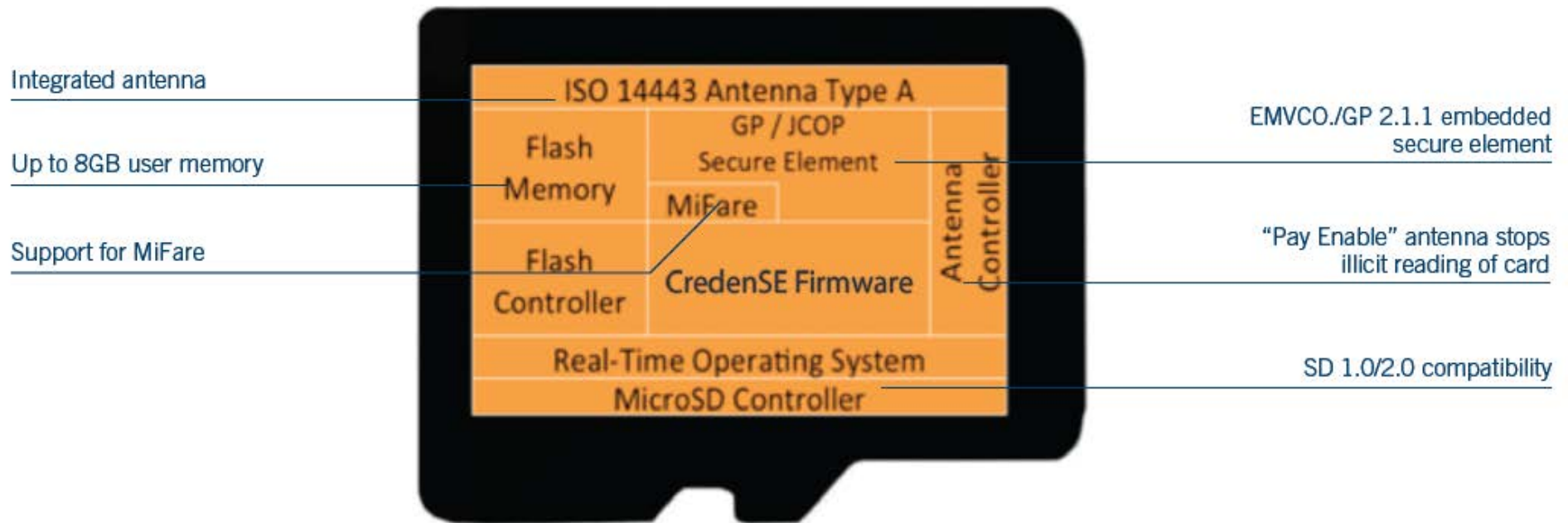
Cards are removable

**3** Embedded chip



Chip wired into phone

# An NFC microSD-based Secure Element (SE)



The microSD secure element includes an integrated antenna (read range 1cm to 2.5cm) that is optimized for consistent RF performance across multiple readers and mobile phones.

# An NFC microSD-based Secure Element (SE)

Module Specifications			
<b>Common Features</b>	BLANK	microNFC 3.2	CredenSE 2.10J
<b>AVAILABILITY</b>	Status and plan	Available	Available
<b>RTE SPECIFICATIONS</b>	Global platform	v2.2	v2.1.1
	JavaCard	v3.0.1	3.0.1 classic
	EMVco	Yes	Yes
<b>PAYMENT CERTIFICATIONS</b>	Visa	VMPA UICC17	VMPA 1.4.1 (c12)
	MasterCard	MMPP 1.0	MMPP 1.0 (in ROM)
	Amex	Yes	No
	Discover	Yes	No
<b>COMMUNICATION</b>	Contactless T=CL	Yes	Yes
	ISO 14443 Type A	Yes	Yes
	ISO 14443 Type B	Yes	No
	ISO7816 APDU, T=0 and T=1	Yes	Yes
	MiFare Tag	Available as an option	Yes
	ISO 18092	Yes	No
<b>USE OF SE</b>	NFC Card Emulation	Yes	Yes
	Contactless Card	Yes	Yes
	Host Applications	Yes	Yes
<b>HOST APIs AND SDK</b>	Android	Yes	v2.1 and above
	BlackBerry	Yes	v4 and above
	J2ME	Yes	Expected
	Windows mobile 8	Yes	Expected
	China Union Pay (CUP)	Yes	Yes
	Windows PC	With adaptor	Java APIs
	iOS (iCaisse and OEMs)	Recommended choice	Partial support
<b>PAYMENT CONTROL</b>	PPSE applet to load	Yes	Yes
	Power by field	Configurable	No
<b>RF PREFERENCES</b>	Onboard CLF Amplifier	No	Yes
<b>AVAILABLE APPLETS</b>	Visa	See certification	See certification
	MasterCard	See certification	See certification
	MiFare for Mobile M4M	Multi MiFare profile mngt	M4M 1.0N R3
	MiFare emulation	1k	Flex classic 4k
	Multi Instance	Yes	Yes
	HID iClass	No	No
<b>APPLET STORAGE</b>		256k total	140k
<b>ROM</b>	Applet ROM	No ROM	MiFare, MMPP, PPSE
<b>microSD CAPACITY</b>	User Storage	None	4GB to 8GB
<b>TARGET PHONES</b>	Blackberry	Yes*	Yes
	Android	Yes*	Yes
	iPhone4/4S	Yes	Yes**
	iPhone5	Yes	Yes**

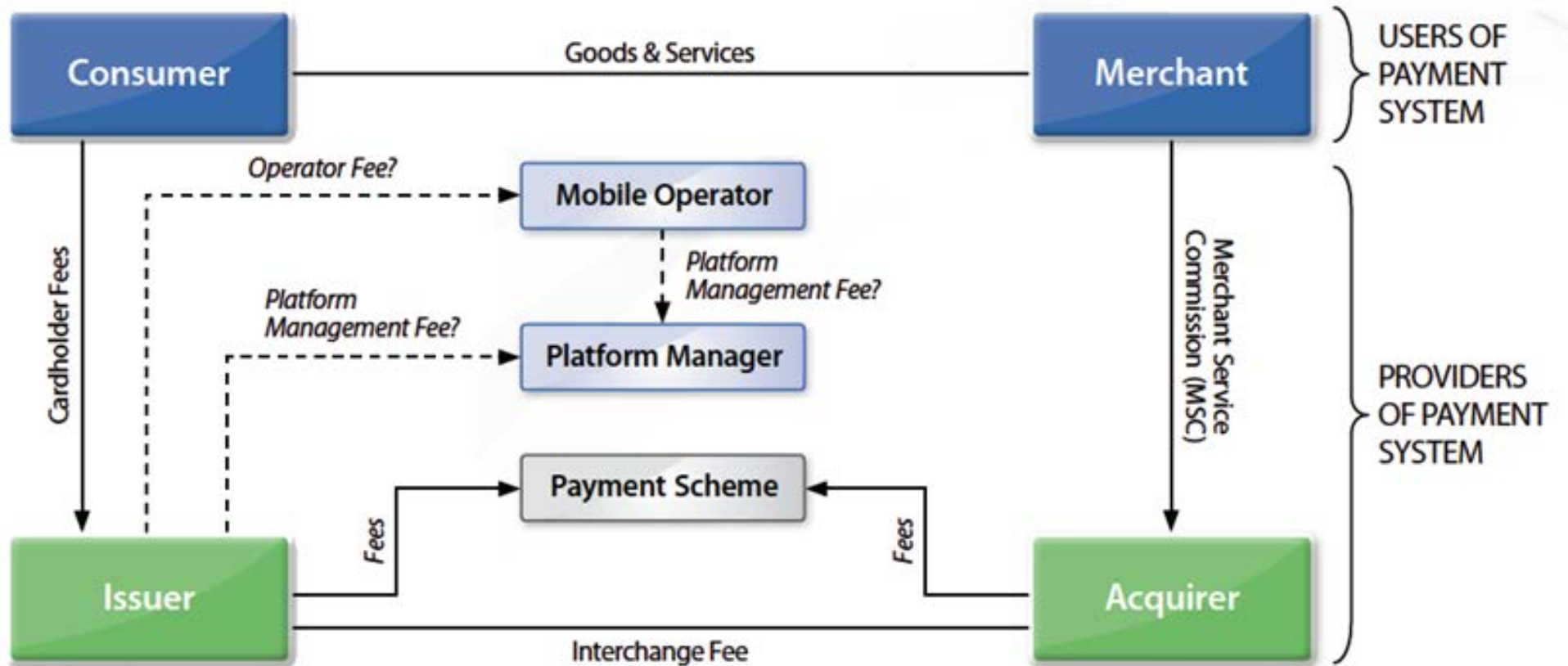
\*For non-NFC applications only

\*\*For card emulation applications only

## Comparison of Different NFC Mobile Payment Devices

NFC device	SIM card	Micro-SD	Phone sleeve	Audio jack device
Device ownership	MNO	Bank	Bank	Bank
Handle multiple payment cards	Yes	Yes	Yes	Yes
Require an NFC-enabled phone	Yes	Yes	No	No
Collaboration with MNO	Yes	No	No	No
Impact on MNO change	Change SIM	Nil	Nil	Nil
Impact on mobile phone change	Nil	Nil	Change sleeve	Nil
Device cost	Low	Medium	High	High

# Participants of Mobile Payment



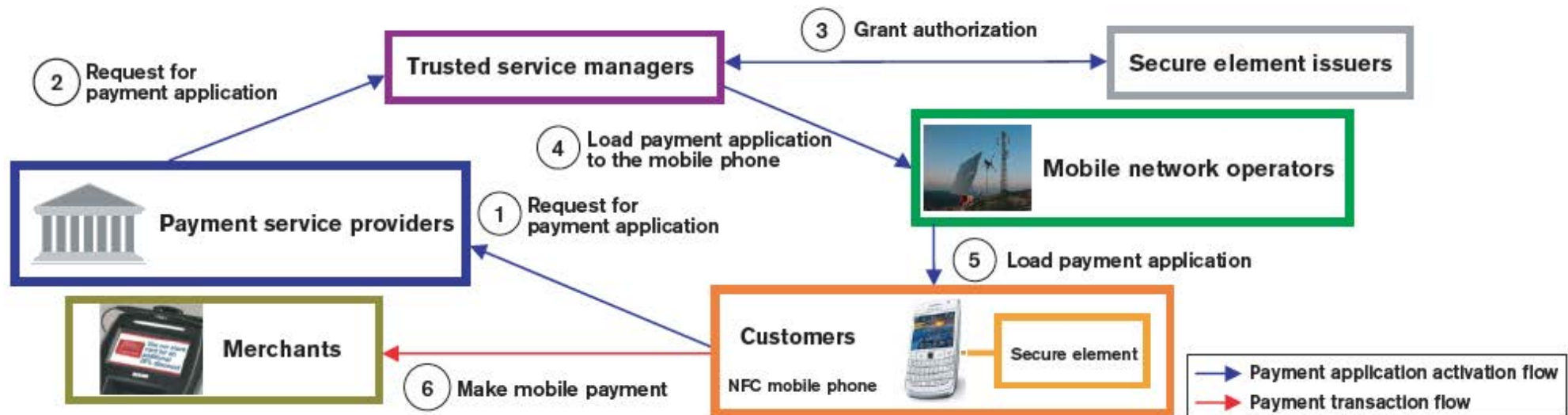
SOURCE: EDGAR, DUNN & COMPANY



## Companies From Six Different Industries are Influencing the Mobile Payments Conversation



# The NFC Mobile Payment Infrastructure & Approaches



Approach	Example
<b>Government-driven:</b> both government and industry consortium sponsor the development of an interoperable NFC mobile payment infrastructure	Info-communications Development Authority of Singapore's NFC Payment and Mobile Services Initiative <sup>(a)</sup>
<b>A mobile network operator-driven approach:</b> joint venture set up by mobile network operators, with minimal or no government authorities' involvement	Project Oscar <sup>(b)</sup> in the UK and ISIS <sup>(c)</sup> in the US
<b>A cross-industry consortium approach:</b> joint industry consortium formed by both mobile network operators and payment service providers, with minimal or no government authorities' involvement	Association Française du Sans Contact Mobile in France (see Box 2 on a case study on the NFC project in France)

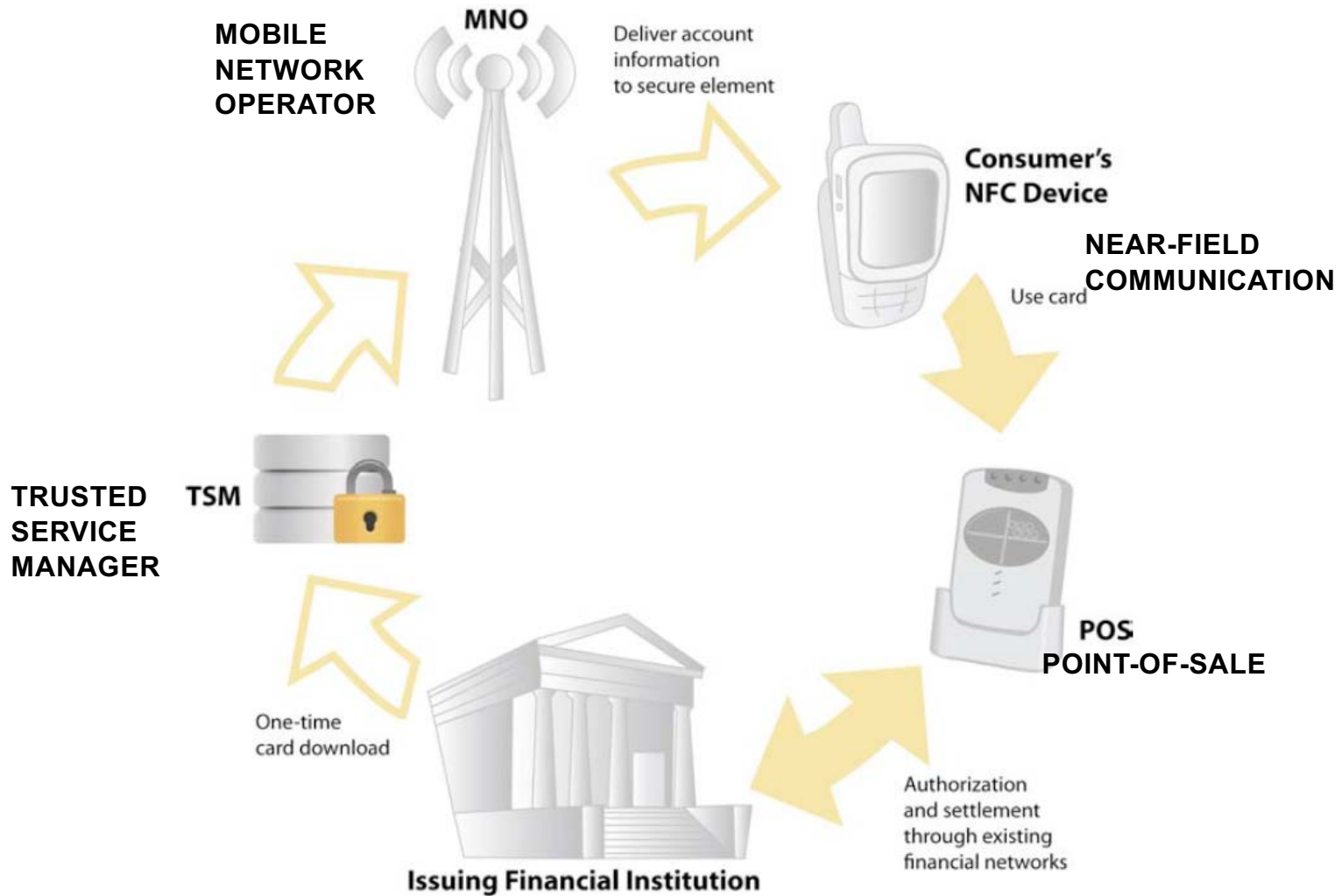
Notes:

(a) See Info-communications Development Authority of Singapore website ([www.ida.gov.sg](http://www.ida.gov.sg)).

(b) See the Guardian's article "Project Oscar hopes to bring mobile wallets to Europe" issued on 7 March 2012.

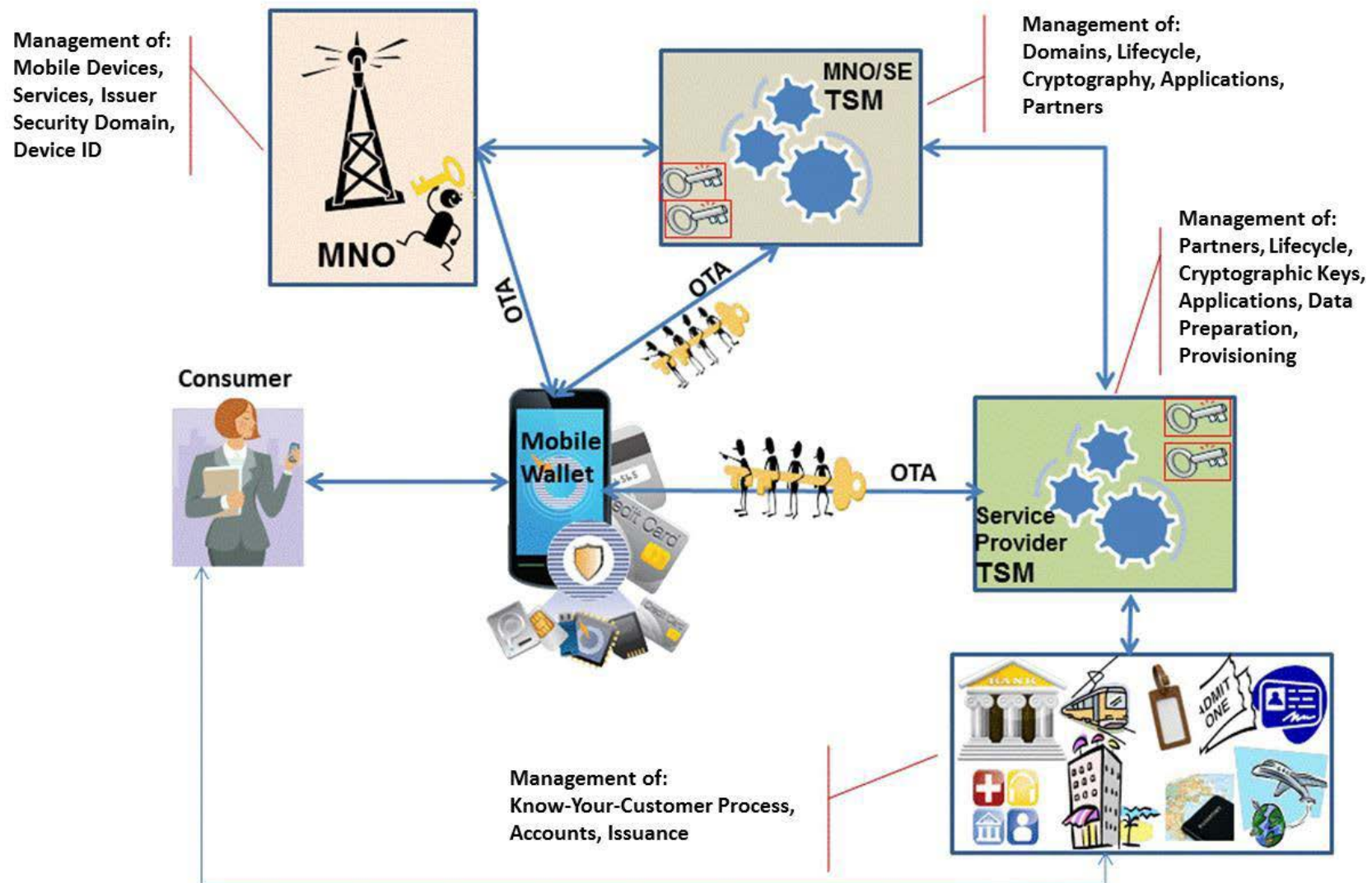
(c) See ISIS website ([www.paywithisis.com](http://www.paywithisis.com)).

# Mobile Payment Ecosystem



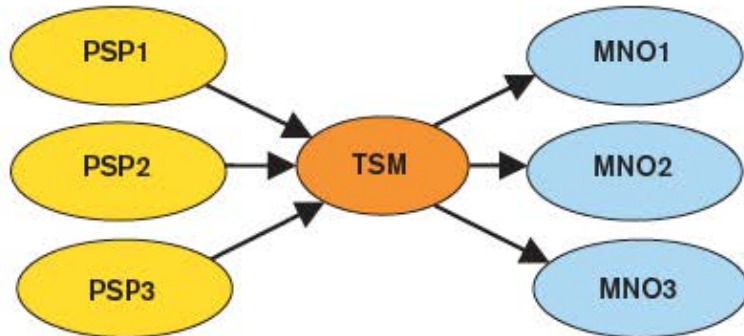
SOURCE: SMART CARD ALLIANCE

# Use of a Trust Service Manager (TSM) to Provision Credentials to the Secure Element (SE)

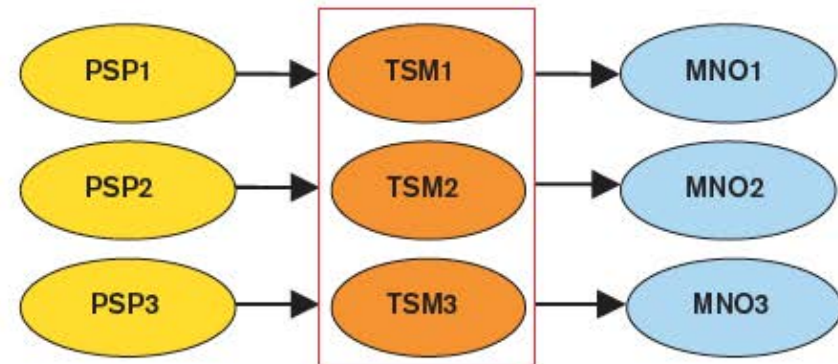


# Scenario Analysis of NFC Mobile Payment Infrastructure

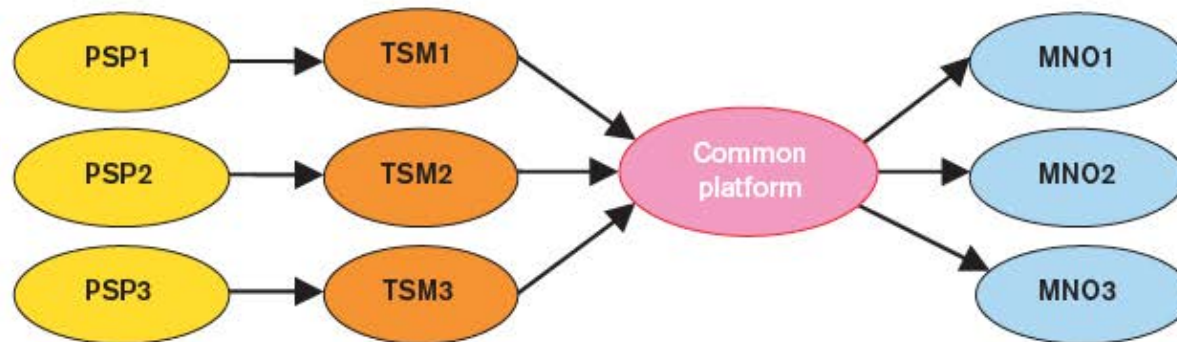
Scenario 1: One common TSM



Scenario 2: Multiple interoperable TSMs



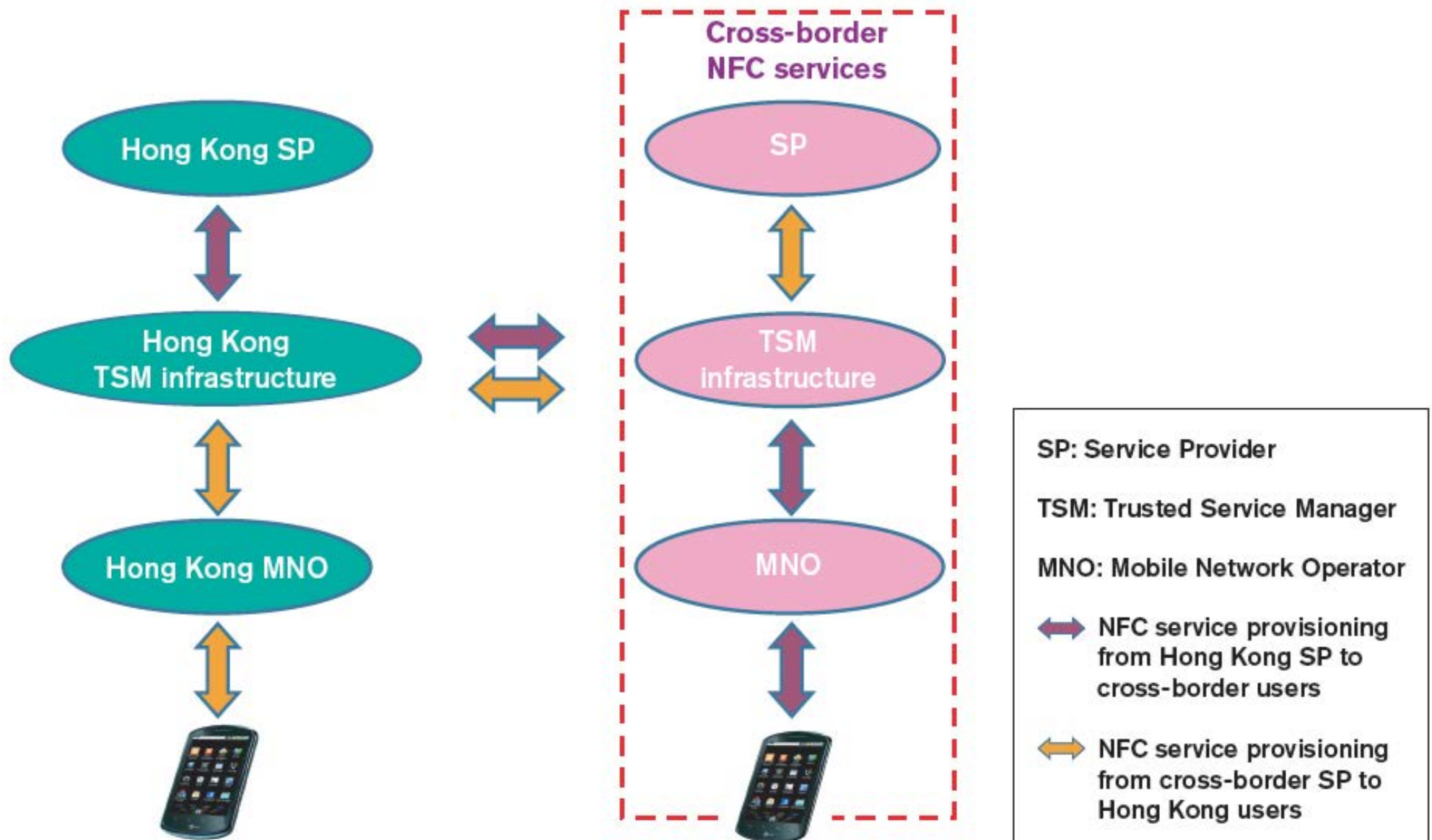
Scenario 3: Common platform connecting to multiple TSMs



PSP: Payment Service Provider  
TSM: Trusted Service Manager  
MNO: Mobile Network Operator

Or none of the above !

# Cross-Border NFC Mobile Payment Infrastructure



# Interoperability Model with Multiple Payment Service Providers connecting to Multiple types of NFC Payment Devices



# Where to Store Payment Credentials ?

Possible Choices:

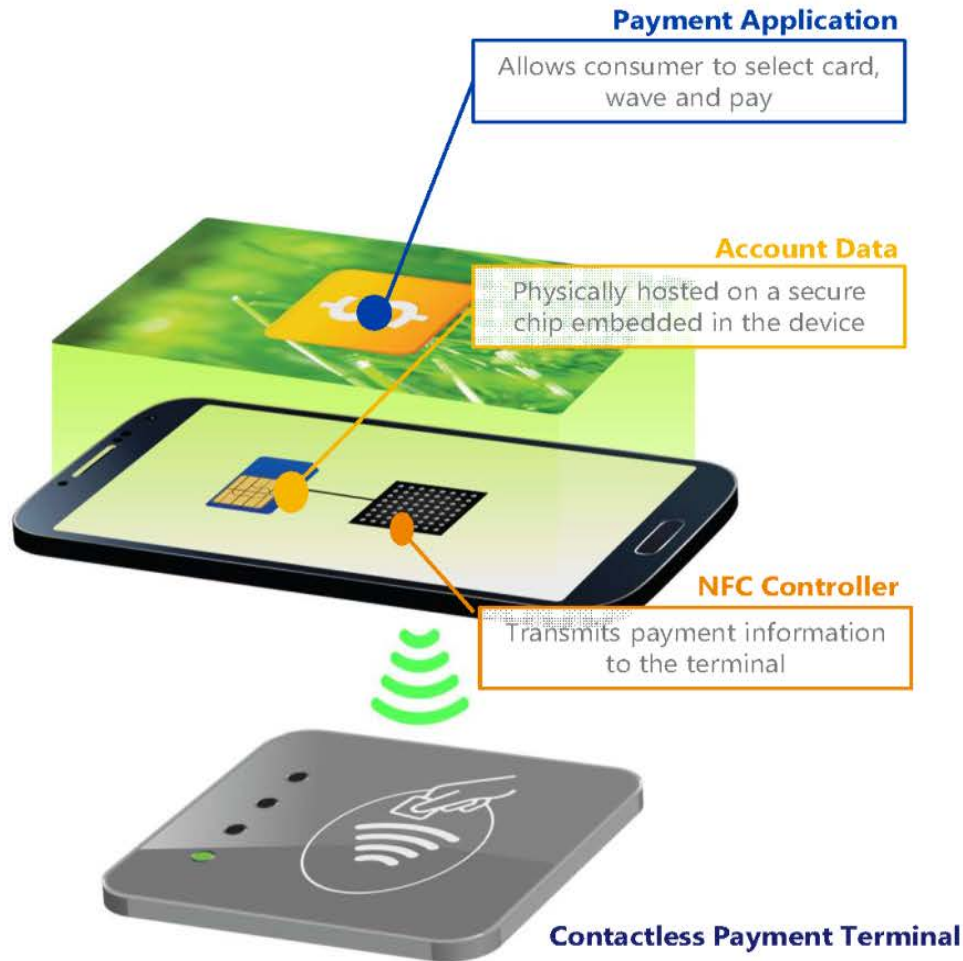


SOURCE: FIRST DATA

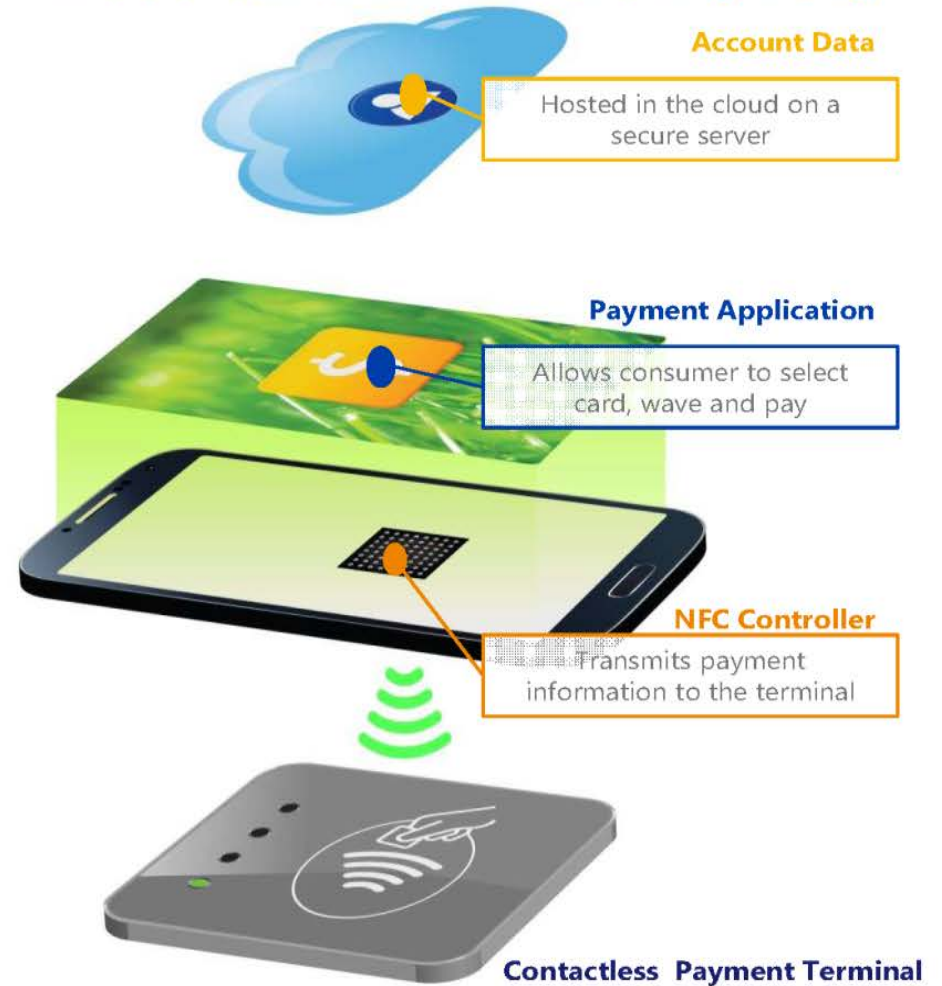


# On-Device vs. Cloud-Based Payments

## Secure Element



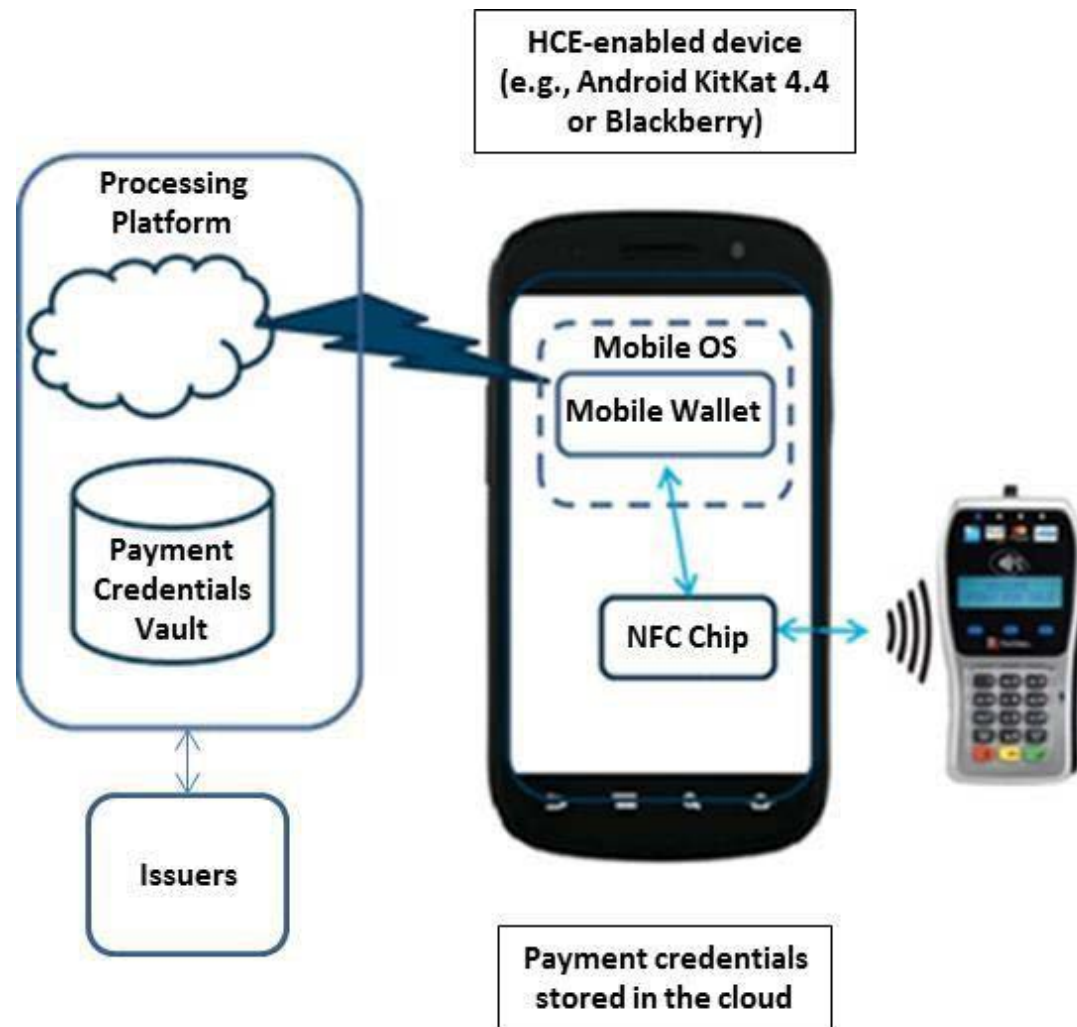
## Host Card Emulation (HCE)



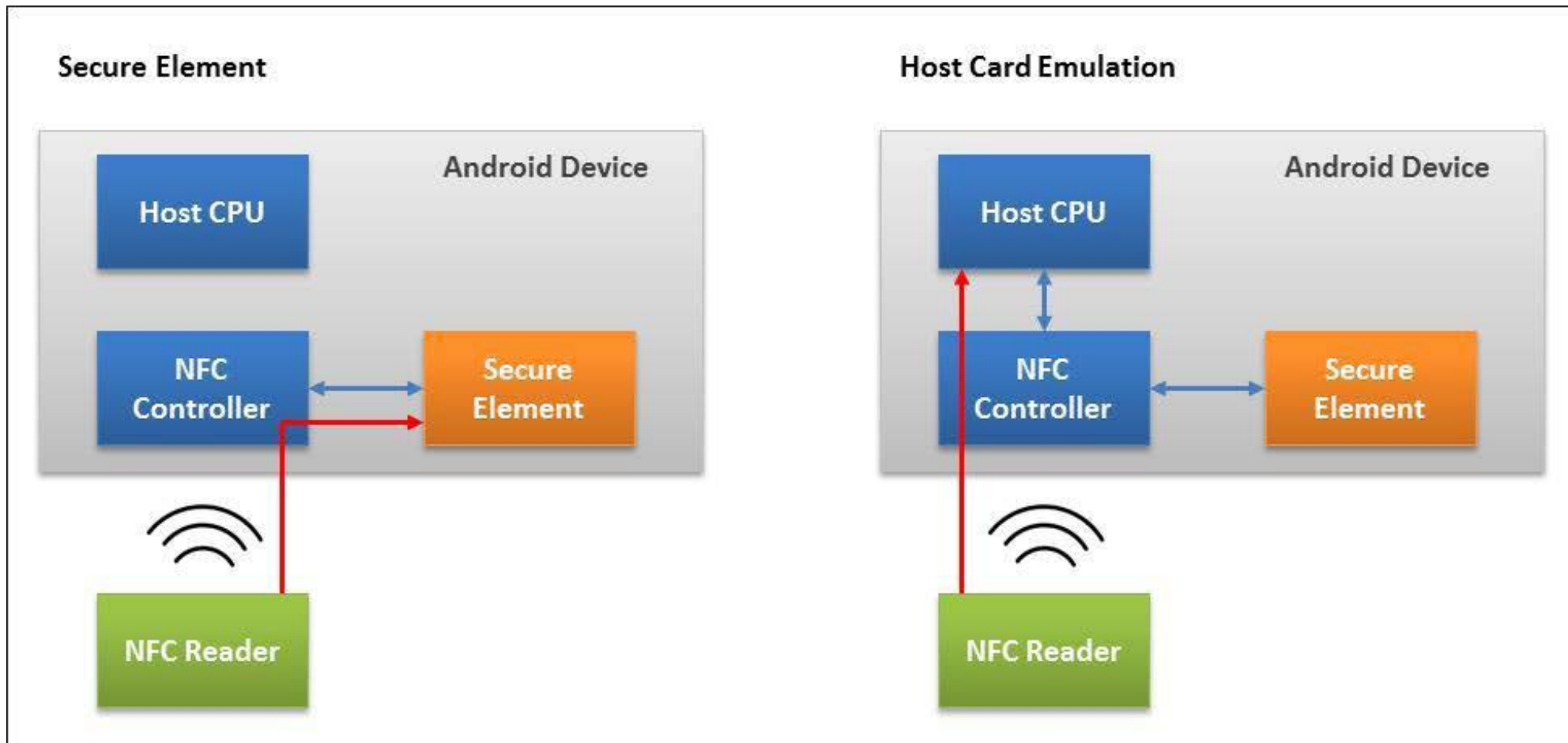
# “Liberation” with Host Card Emulation (HCE) for NFC

- Since Android 4.4, an alternative approach called Host-based Card Emulation (HCE) has been introduced which allows the NFC controller to route communications from the contactless card reader/ POS terminal to an HCE service, instead of to a **smartcard-based app running inside the SE**.
- The HCE service can be part of a mobile app, e.g. mobile wallet, running on the mobile device's **host CPU**.
- Under HCE, the payment credentials can be stored in :
  - ✦ an SE on the mobile device or
  - ✦ the Cloud, with some **short-lived** credentials cached in the device, or
  - ✦ in a Trusted Execution Environment (TEE) on the main processor of the mobile device, or
  - ✦ in the mobile application/ OS itself (probably with software obfuscation, e.g. **White Box Cryptography**)
- Most importantly, **HCE removes the dependencies on the SE and TSM infrastructure** and the need to set commercial agreements with secure element issuers (SEIs).
- **HCE enables the development of Mobile Apps that can function as a smart card** to perform contactless Payment/ Security-sensitive applications even without a mandatory hardware-based SE !!

# Obtaining Credentials from the Cloud using Host Card Emulation (HCE)



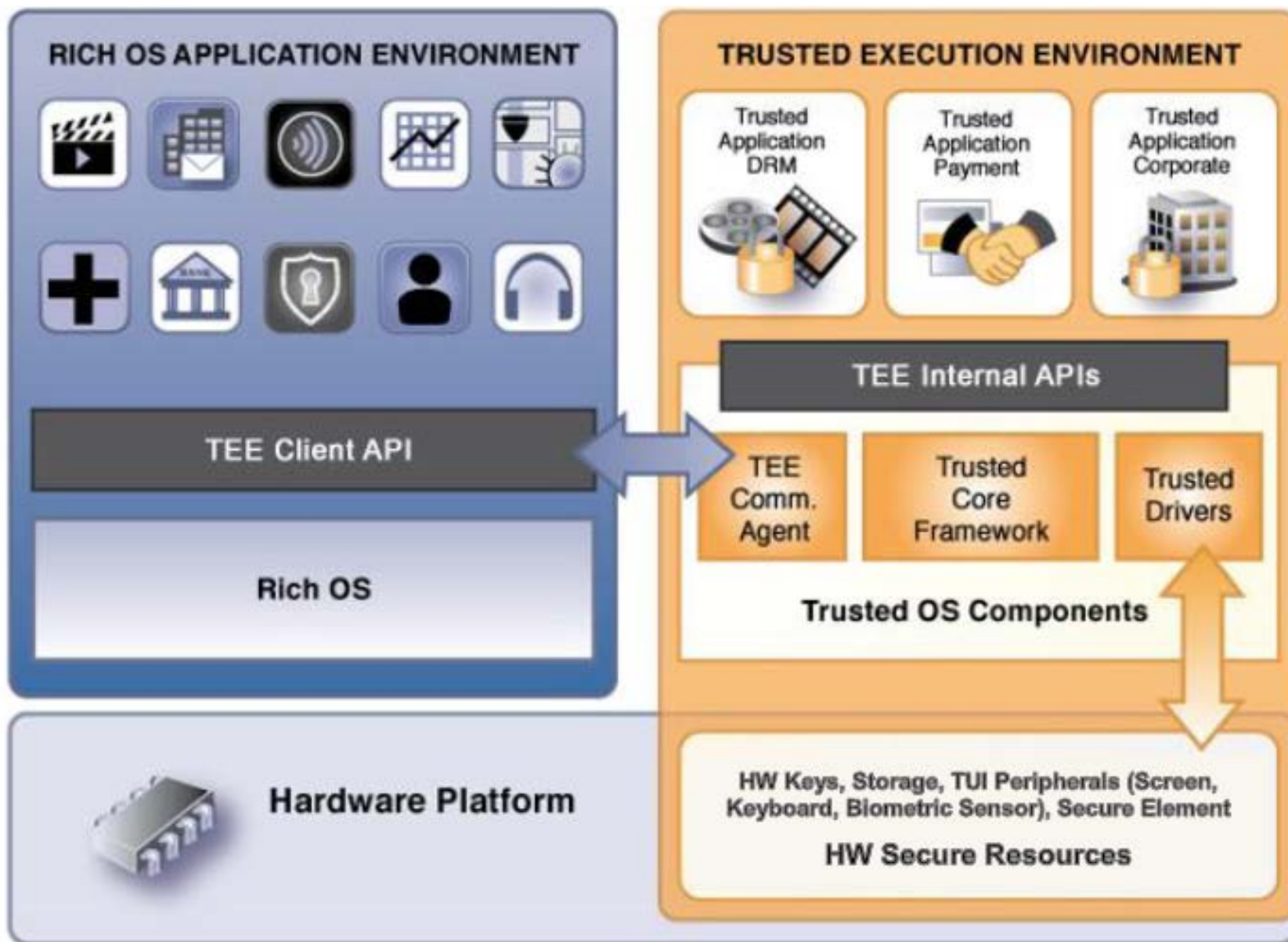
# NFC Communications with Secure Element (SE) vs with Host CPU + HCE



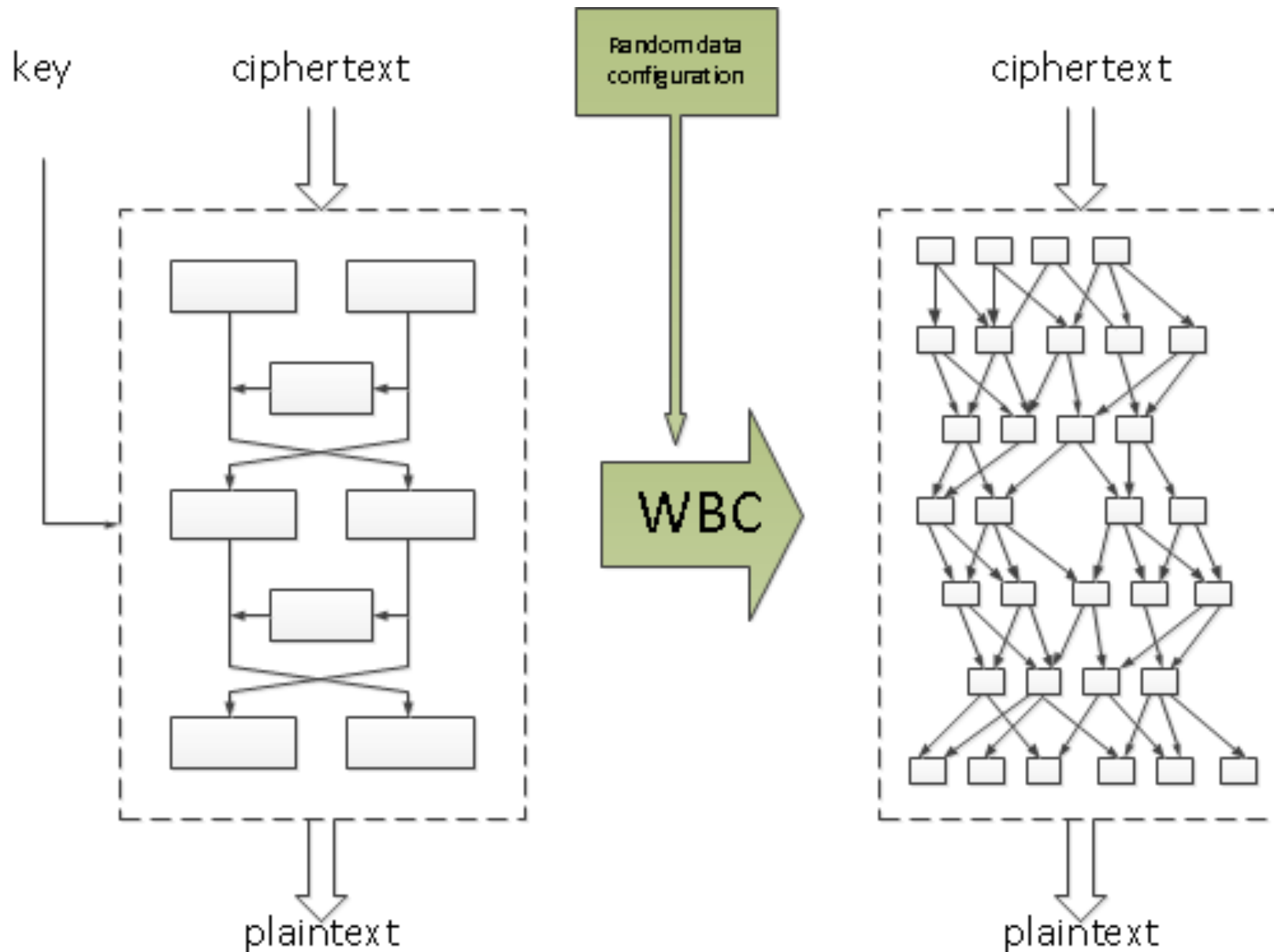
# HCE service with different SE form factors



# Architecture of Trust Execution Environment (TEE)



# White Box Cryptography (WBC)



Source: Brecht Wyseur, "White-box cryptography: hiding keys in software", MISC magazine, April 2012, [http://www.whiteboxcrypto.com/files/2012\\_misc.pdf](http://www.whiteboxcrypto.com/files/2012_misc.pdf)

# Different Approaches to realize Card Emulation: SE vs. TEE vs. OS w/ Software Protection

Property	SE	TEE	OS with Software Protection
Level of code and data protection	Best Tamper-resistant	Better Hardware secured	Good
Memory and computation performance	Limited	Maximum	Maximum*
Executed on the main processor	No	Yes**	Yes
Secure peripheral access	No	Yes	No
Provides device attestation	Limited	Yes	No
Software ecosystem	Limited	Yes	Yes
Use case support	Limited	Unlimited	Unlimited

\*Some software protection mechanisms impact performance.

\*\*May run on a separate processor.

Source: Trustonic.

Note: Apple Pay does not do HCE, it uses an embedded Secure Element (eSE) on the IOS device to store payment credentials and assist in generating one-time code for each payment transaction. Under Host Card Emulation (HCE), there are different storage options for payment credentials: Samsung Pay also has an eSE but supports the HCE approach with TEE and Cloud-based solution ; Google Pay supports the eSE (in Pixel phones), TEE as well as pure OS/SW protection approach (in the last case, long-term payment credentials will only be stored in the Cloud );



# Considerations of the SE-based vs. Host-based Card Emulation Approach

Areas of Consideration	Secure Element	Host Card Emulation
<b>User Experience</b>		
Battery consumption	Battery consumption can be less, based on implementation.	Since host OS interaction is required, higher power consumption can be expected.
Battery-off function	Possible to work in low or no battery modes. <sup>32</sup>	Requires battery power.
Mobile devices supported	Secure elements and apps work on NFC-enabled mobile devices.	Currently supported on Android 4.4 or higher and Blackberry OS 7 or higher. Specific app versions are required for each OS.
Mobile device change	Managed through the TSM.	Managed by the solution provider.
Latency for accessing credential during a transaction	Credentials are readily available as they are stored inside the SE locally.	A pure cloud-based storage solution is problematic due to latency. Credentials (either static or tokens) must be already in the device when the NFC transaction takes place.
Life cycle management	Only needed for static credentials and apps. Defined by GlobalPlatform standards. Same for all payment brands for payment applications.	Needed for apps, static credentials and tokens (if required by use case to mitigate risk). Life cycle management solution is proprietary for each payment brand for payment applications.
Maturity of deployments	Many commercial deployments around the world over the last 3 – 4 years.	A few commercial solutions.
Device connectivity to mobile network or WiFi	Required only for provisioning of credentials. Transactions do not require device to be connected to the network.	Required for provisioning of credentials. Transactions may require network connectivity to mitigate security risks (e.g., if solution requires tokenization, connectivity would be required to acquire/refresh tokens).
Online/offline acceptance infrastructure for transactions	Both online/offline modes are supported.	Significant security challenges exist to support offline mode.

# SE-based vs. Host-based Card Emulation

Areas of Consideration	Secure Element	Host Card Emulation
Implementation		
AID conflicts	Strict AID rules.	Can share and reuse AIDs between client mobile applications.
Approach for provisioning and managing credentials	Managed through TSM infrastructure for SE-based applications; does not require tokenization for sensitive credentials.	Managed through the application. Complexity grows when risk mitigation techniques need to be introduced.
Co-existence with other credential storage form factors	SE can co-exist with HCE, depending on OS vendor implementation.	HCE can co-exist with SE, depending on OS vendor implementation.
Cost	Determined by the owner of the SE. Main cost components are typically SE rental fees and TSM infrastructure.	Service provider does not need to negotiate SE rental fees. IHCE implementation still needs an infrastructure to provision credentials into the mobile device. If the use case requires tokenization to mitigate risk of exposure of the credentials, cost of the tokenization infrastructure must be factored in.
Credential storage options	Stored inside SE and highly tamper proof.	Can be stored in the cloud or in the host CPU with the use of OS-based cryptography; can be stored in an SE or the TEE on the mobile device.
Memory limitation	SE chip may have memory limitations and is a consideration.	No memory limitation.
Provisioning infrastructure	TSM is necessary to create security domains, provision apps and credentials, and provide lifecycle management.	Provisioning infrastructure is required to manage credentials and tokens. Requires active lifecycle management for credentials/tokens.
Real-time changes to applications	Possible to change applets through SE infrastructure. GlobalPlatform specifications are being used for management.	Same process as used for updating any mobile app.
Secure element issuer (SEI)	SEI participates in both business model and technical implementation, as it owns the SE that will hold the application/credentials and must allocate a partition to each service provider wanting to use the SE.	No SEI is involved but infrastructure needs to be implemented to mitigate security risks for credentials stored with the application in the mobile device.

# SE-based vs. Host-based Card Emulation

Areas of Consideration	Secure Element	Host Card Emulation
<b>Standards and Specifications</b>		
Certification criteria	Very well defined by all payment brands for payment applications.	Currently not defined by any payment brand for payment applications.
Maturity of the technology	Backed by strong and mature standards.	Mobile OS implementation of HCE is immature.
Maturity of the specifications	Backed by strong and mature standards for the SE and applications.	Specifications supporting HCE are evolving and need to be harmonized across OS vendors. Proprietary payment specifications are either immature or unreleased.
Standards and interoperability	Standards support interoperability at provisioning, secure element, NFC radio, mobile OS, and payment and transit application levels.	Only EMVCo tokenization and two proprietary payment brand specifications are available for interoperable payment applications.
Standards and specifications	GlobalPlatform, ETSI, ISO/IEC 14443, ISO/IEC 7816, ISO/IEC 18092, MIFARE, and all global payment brands.	ISO/IEC 14443, ISO/IEC 7816, ISO/IEC 18092 and two global payment brand specifications.

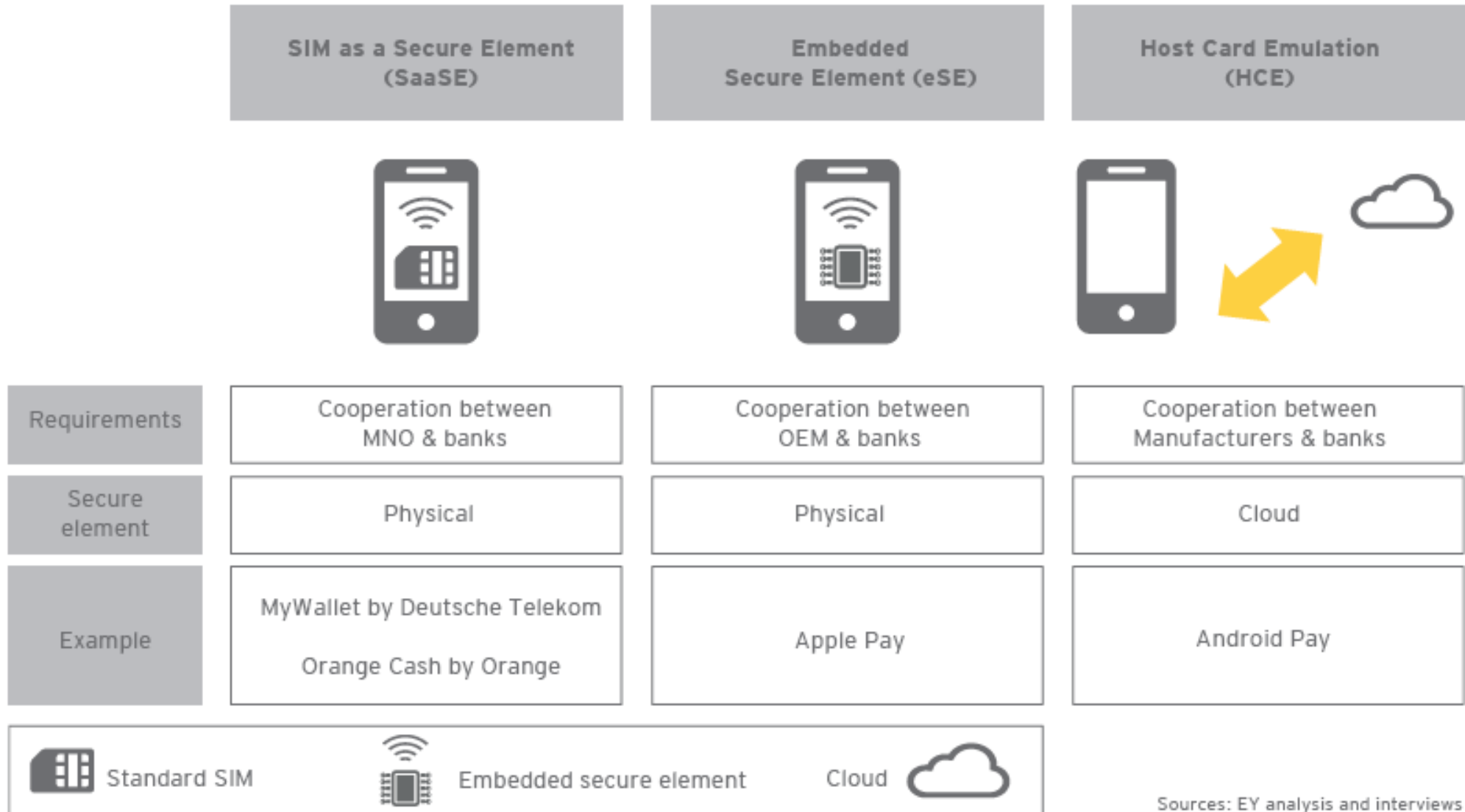
# SE-based vs. Host-based Card Emulation

Areas of Consideration	Secure Element	Host Card Emulation
<b>Security</b>		
Cryptography	GlobalPlatform session encryption keys are employed to protect the payload being provisioned to and stored on the SE.	Application-specific.
Risk of malware attack	None. SE is isolated from the mobile OS during transaction.	The HCE app resides in an open and connected mobile OS, and is subject to malware attacks like any other mobile app on the phone.
Security	Highly secure due to protection of data inside tamper-proof module.	Lower security level due to software-based storage. Risk mitigation can be achieved by tokens, additional authentication methods and/or software-based security approaches.
Tokenization of credentials	Possible, but not required even for open loop payments. Credentials are safely stored in the SE.	Likely to be required for open loop payment. It may be advisable for other use cases dealing with sensitive credentials. Could present customer service issues if tokens change per transaction.

# SE-based vs. Host-based Card Emulation
















Areas of Consideration	Secure Element	Host Card Emulation
<b>Use Cases</b>		
Closed loop payment	Requires similar infrastructure to open loop.	HCE services for closed loop are straightforward to implement.
Card-present/card-not-present status for face-to-face payment transactions	Payment transactions are considered card-present.	Will be based on payment network policy.
EMV compatibility for payment	EMV contactless compatible, with certification programs enforced.	Can be EMV contactless compatible; currently no certification available.
MIFARE support	Yes.	Currently not available.
Multiple wallet integration	Multiple wallet integration in single device can be complex; OS determines how multiple wallets are handled.	Multiple wallet integration in single device can be complex; OS determines how multiple wallets are handled.
Open loop payments	Supported with credential in SE.	Likely to be supported with tokenized credential.
Transit, loyalty, access applications	Solution providers must coordinate with SE issuers. Can be compatible with most deployed acceptance infrastructures.	Solution providers can implement solutions independently. Backward compatibility issues with deployed acceptance infrastructure must be addressed.

# Comparison of Mobile Payment Initiative Security Models



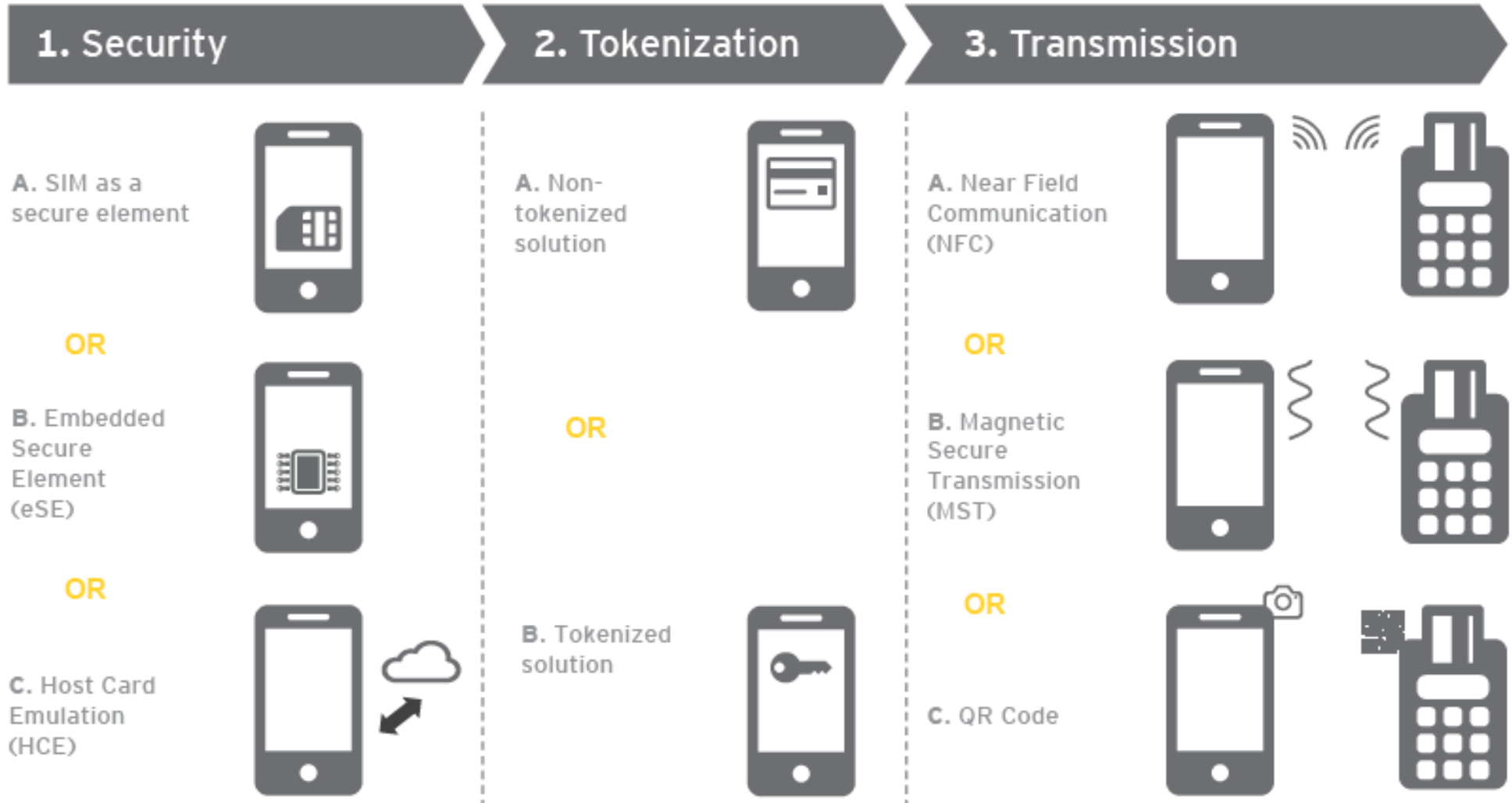
Sources: EY analysis and interviews

# Comparison of Mobile Payment Initiative Communication Models

	Near Field Communication (NFC)	Magnetic Secure Transmission (MST)	QR Code
			
Phone requirement	 Almost half of smartphone shipments in 2015	 All Samsung smartphones from Samsung Galaxy 6	 All smartphones (camera needed to flash QR code on PoS)
PoS requirement	 15% of PoS terminals worldwide in 2014	 All PoS which are compatible with magstripe payment	 All PoS which have a screen in order to display QR Code
Example	Apple Pay      Android Pay	Samsung Pay	CurrentC      Chase Pay
	 NFC  MST  Camera  QR Code		Level of technological penetration  Low  High

Sources: EY analysis and interviews

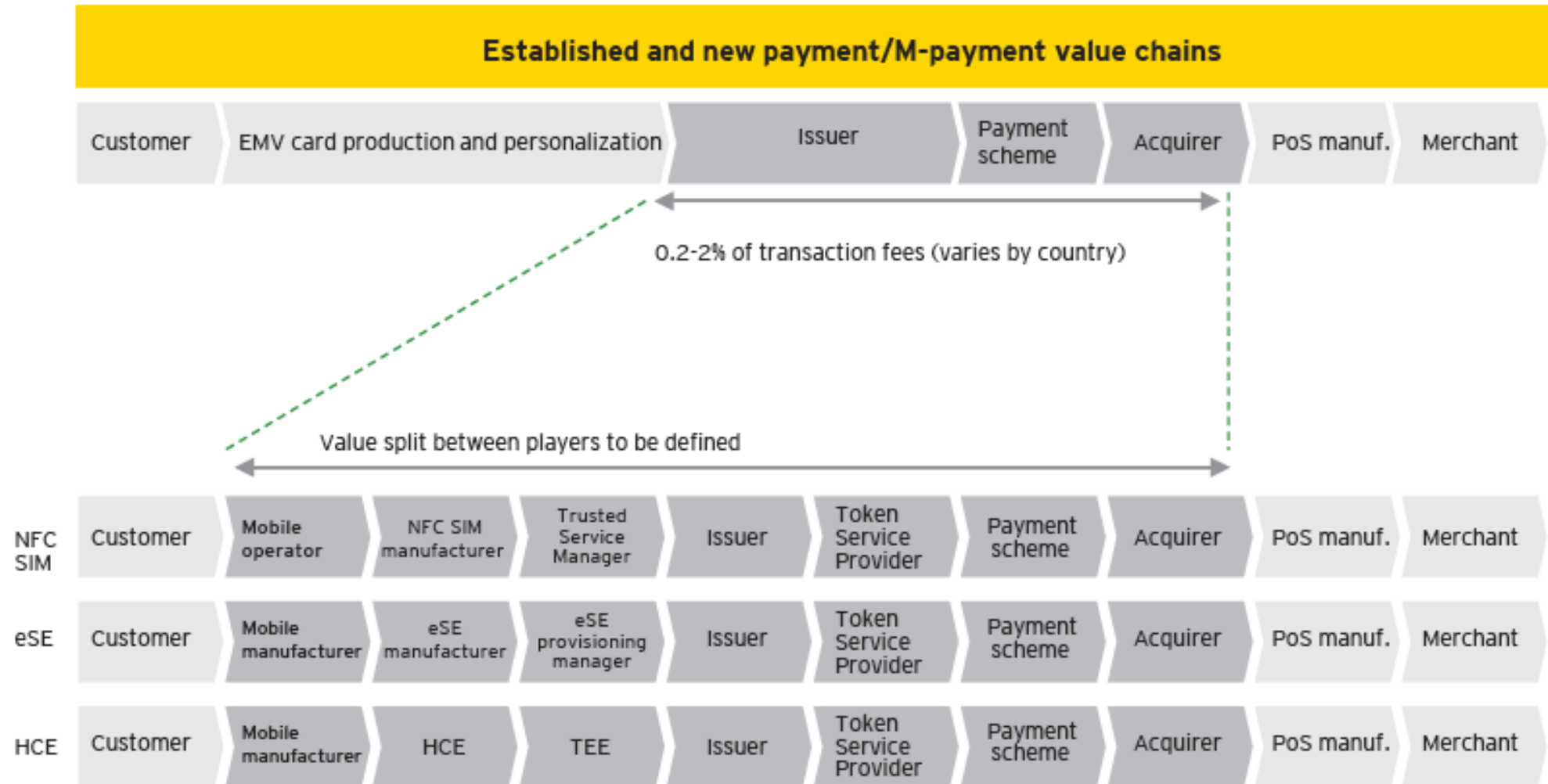
# Comparison of Mobile Payments Approaches



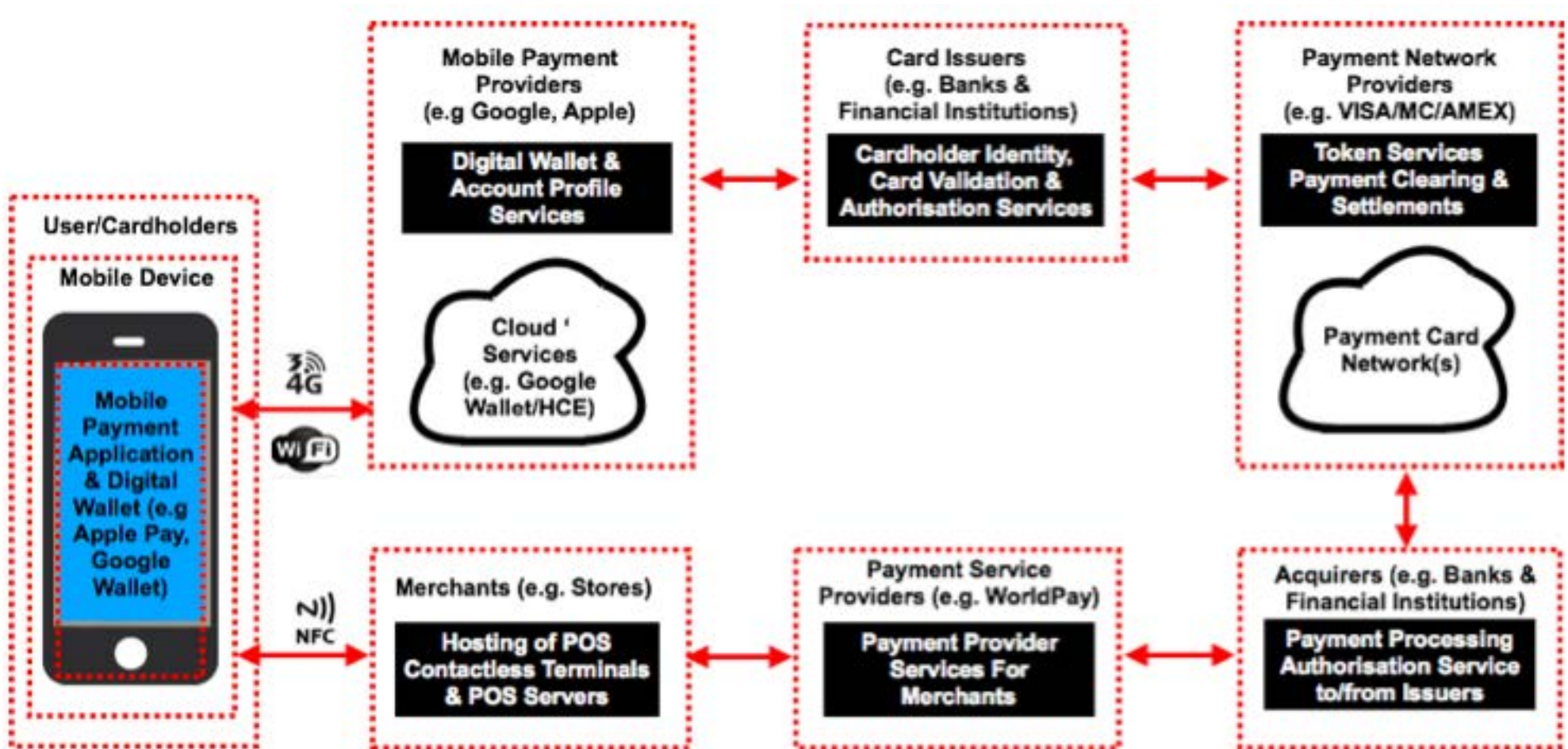
Sources: EY analysis and interviews



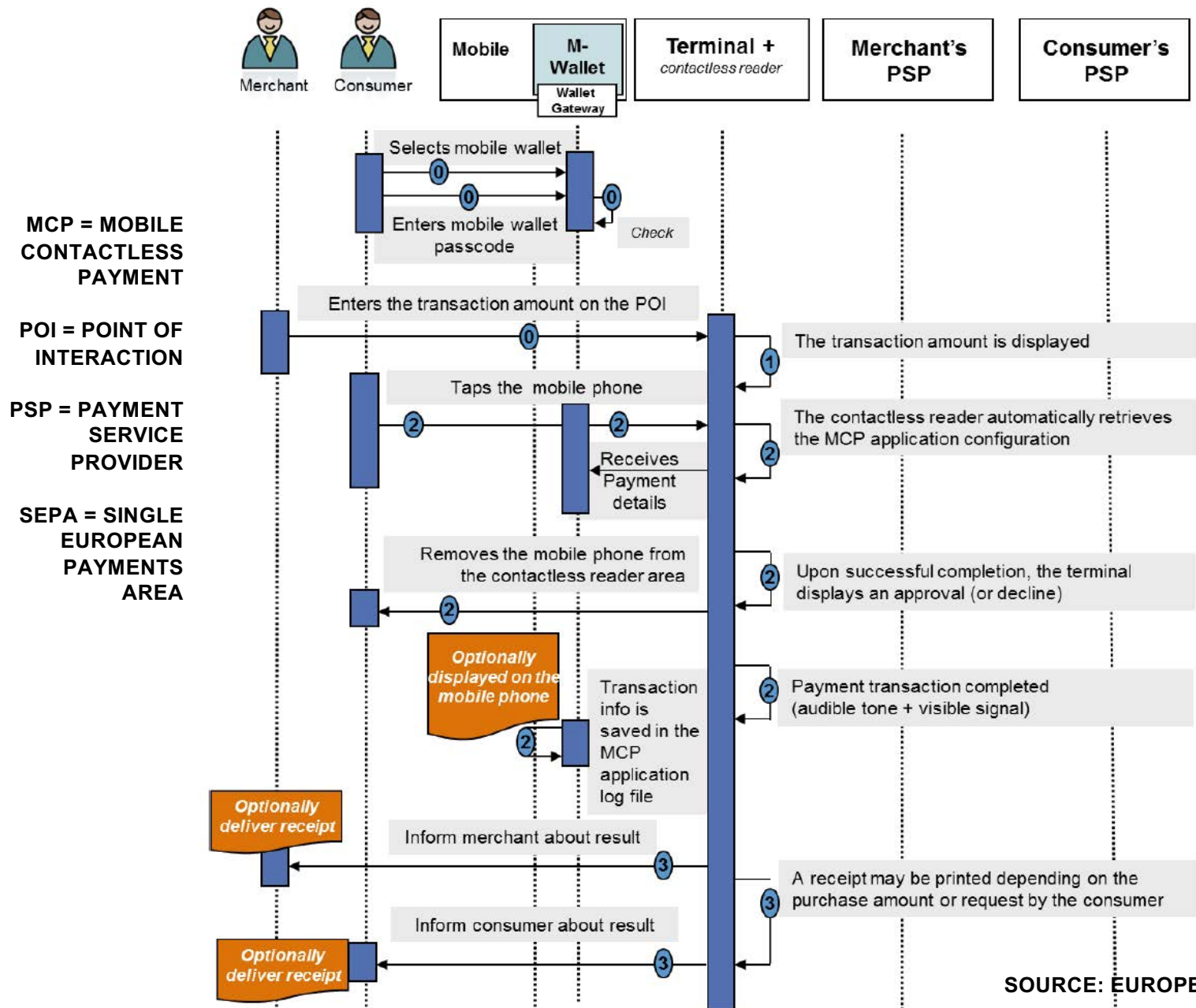
# The Value Chain for Mobile Payment Systems



# Services provided by various Participants of a Mobile Payment System



# Consumer-to-Business Mobile Contactless (SEPA) Card Payment



SOURCE: EUROPEAN PAYMENTS COUNCIL

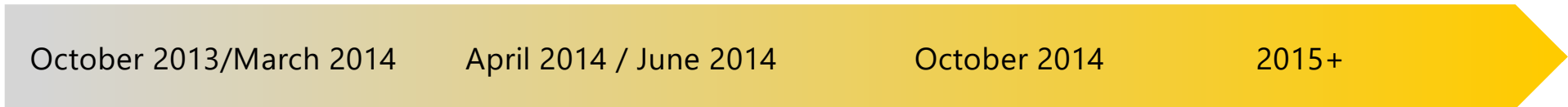
# Tokenization – what is it??

*Tokenization* is the process of replacing the original payment credentials (PAN) with a unique “alternate identifier” which may be used instead to initiate payment activity.

Replaces a traditional card account number with a unique payment token / digital account number

Restricts the use of a payment token by device, merchant, transaction type or channel

*Payment tokens further enhance security of digital payments and simplify purchase experience when shopping on mobile, computers or other smart devices and help reduce fraudulent activity....*



**Industry standard**



**Card Brand enabled**



**Similar techniques taken by other Mobile Wallet solutions, e.g. Google Pay, Samsung Pay, etc...**

## Tokenization (cont'd)

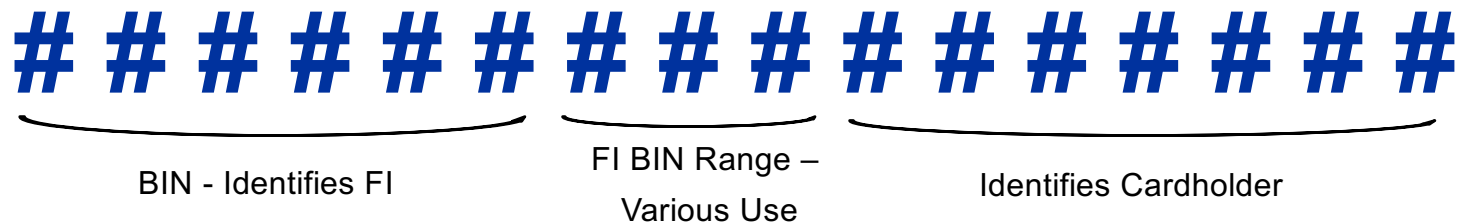
- Tokens are not mathematically derived from information associated with the card (unlike encryption).
- Multiple Payment Tokens can be attached to a single PAN
  - ◆ The card issuer can also re-associate the tokenized number with the PAN for authorization & other purposes
- The tokenized number is otherwise worthless to hackers.
- Made compatible with existing payment technologies and payment transaction routing
- Improved Security and Regulatory Compliant:
  - ◆ For the implementation option of NFC Host Card Emulation (HCE) where there is NO hardware-based SE on the user mobile device to safeguard user's long-term payment credentials (e.g. as in the case of Google Pay), tokenization becomes even more important (and necessary) to provide an extra level of security: namely, even if the software/OS of the mobile device has been compromised, only the short-lived tokens instead of the long-term PAN would be lost.

# Payment Tokens - Token Attributes

- Interoperable with BIN based account numbers / PANs – *PAN / Account Number Validation Rules, Security, Structure and Regulatory Obligations Remain Enforced*
- Distinct and identifiable in system – merchant, consumer device(s) and issuer
- Able to support authentication by different entities and types (Issuer, Wallet, Merchant, etc)

**Tokens add value to the processing environment while improving visibility and protecting cardholder information**

## Existing PAN / Account Number Structure



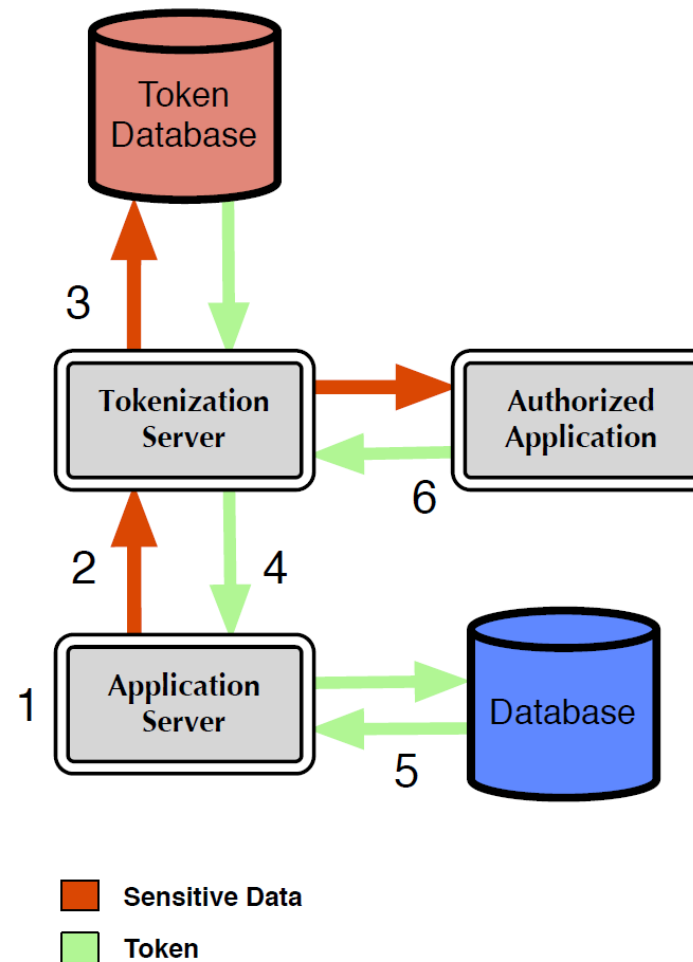
## New Token Structure



# Tokenization

## REPLACING SENSITIVE DATA WITH A PROXY (SUBSTITUTE) – A “TOKEN”

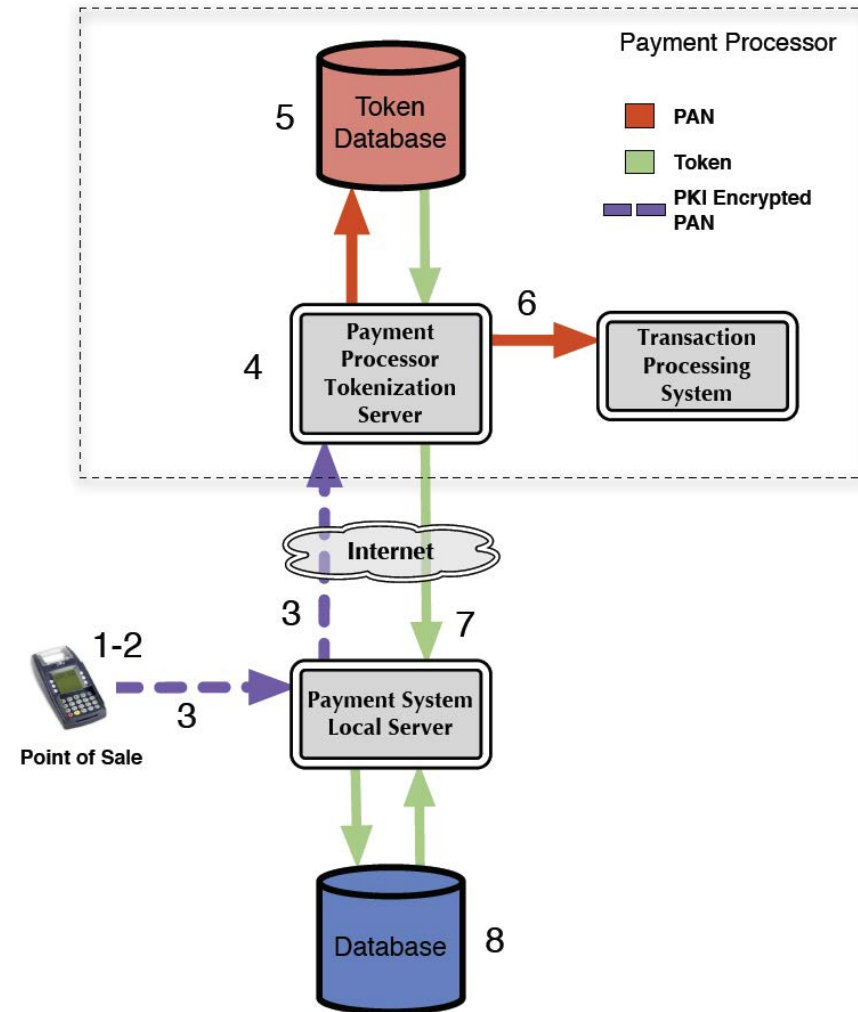
1. Application collects or generates a piece of sensitive data.
2. Data is sent to the tokenization server, **NOT** stored locally.
3. Tokenization server generates a random token. Sensitive data and token are stored in a highly secure and restricted database (usually encrypted).
4. Tokenization server returns the token to the application.
5. Application stores the token, **NOT** the original value. Application uses the token for most transactions.
6. When the sensitive value is needed, an authorized application can request it from the tokenization server. Only authenticated requests will be honored.



SOURCE: SECUROSIS

# Using a Token

1. Retail customer swipes card at PoS.
2. PoS encrypts PAN with the public key of the payment processor's tokenization server.
3. Transaction information (including the PAN, other card data, transaction amount, and merchant ID) are encrypted and transmitted to the payment processor.
4. Payment processor's tokenization server decrypts the PAN and generates a token. If this PAN is already in the token database, either reuse the existing token (multi-use), or generate a new token specific to this transaction (single-use).



SOURCE: SECUROSIS



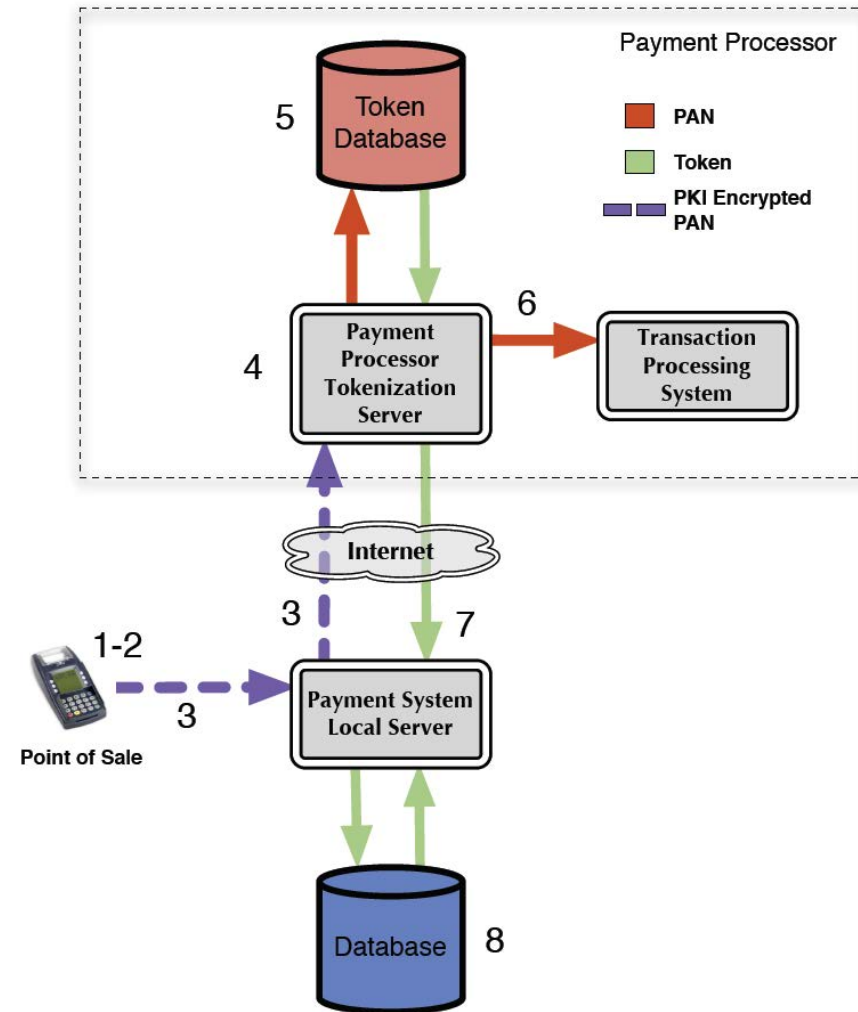
# Using a Token

5. Token, PAN data, and possibly merchant ID are stored in the tokenization database.

6. PAN is used by the payment processor's transaction systems for authorization and charge submission to the issuing bank.

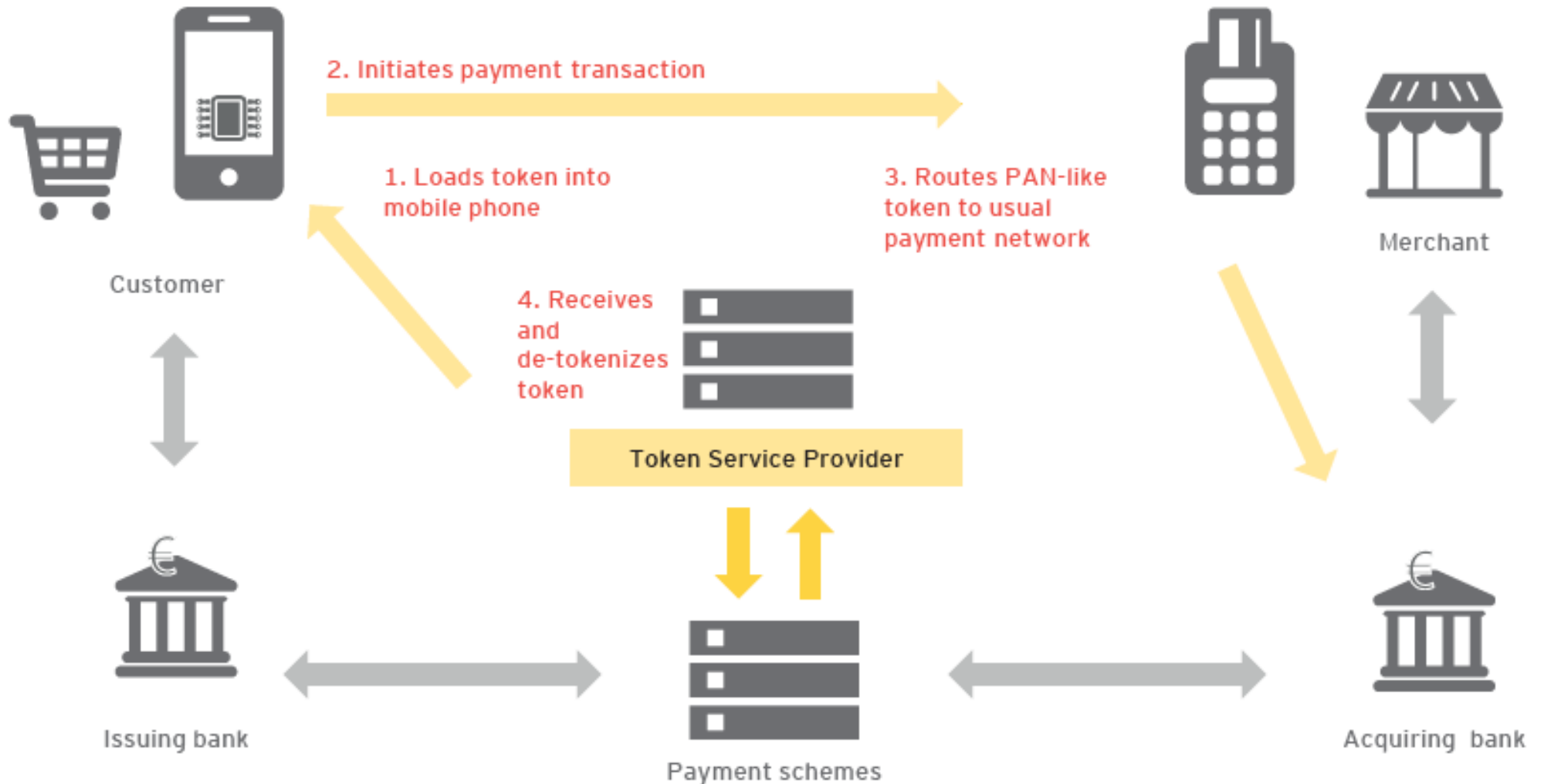
7. Token is returned to the merchant's payment systems, as is the transaction approval/denial, which hands it off to the PoS terminal.

8. Merchant stores the token with the transaction information in their systems/databases. For the subscribing merchant, future requests for settlement and reconciliation to the payment processor reference the token.

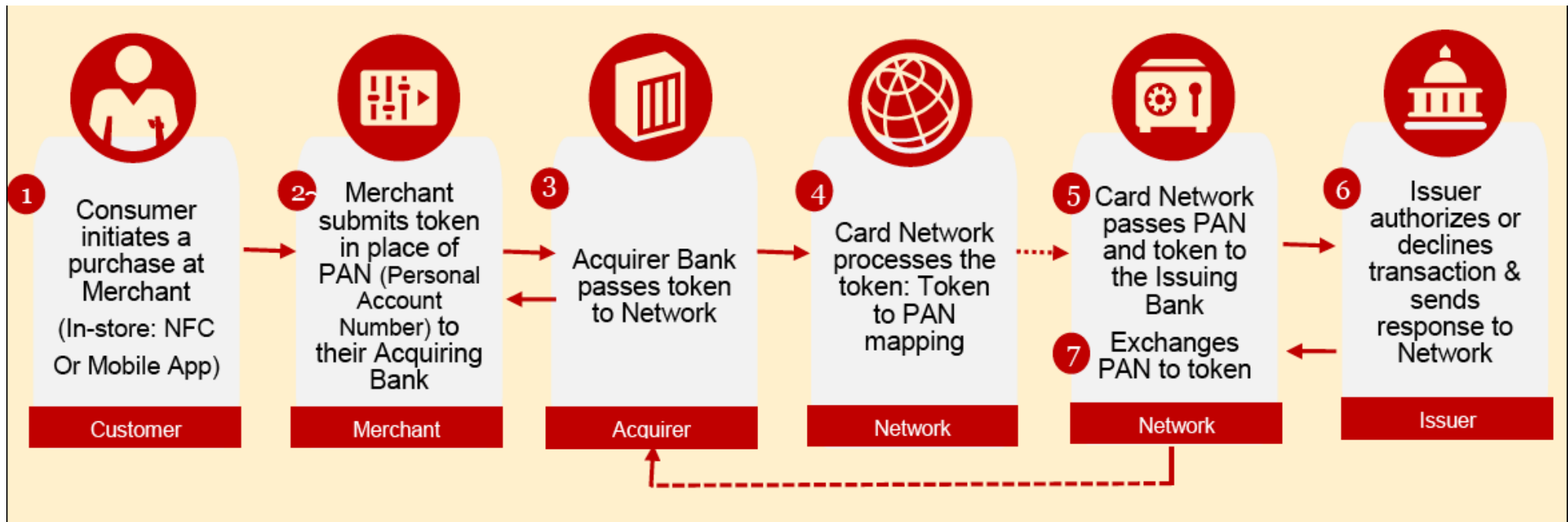


SOURCE: SECUROSIS

# The Tokenization Model



# The Tokenization Model (cont'd)



SOURCE: "Tokenization: The future of Secured Payments," PwC, Jan 2019.

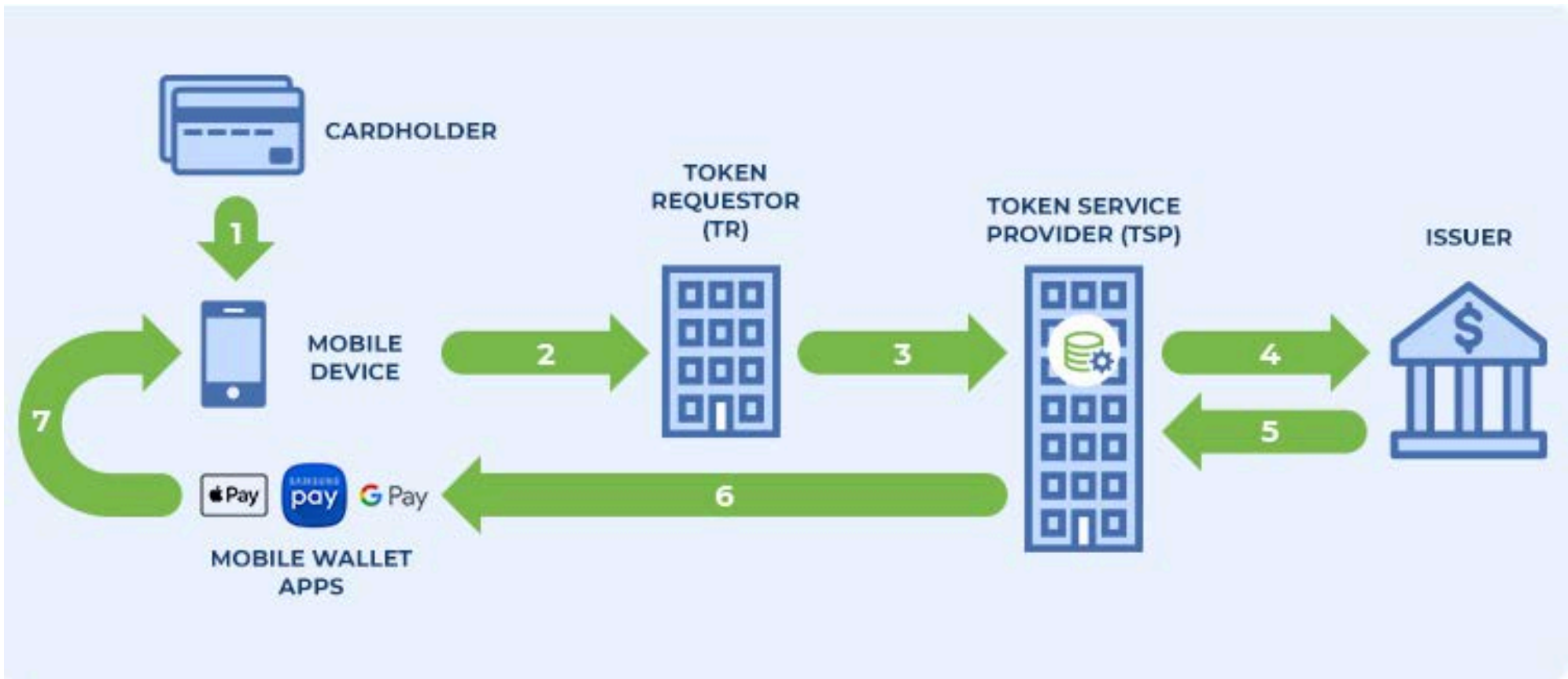
# Different types of Tokens (in detail)

Acquiring tokens	Issuer tokens	Payment tokens
Proprietary token format defined by the entity that generates it (mainly acquirers, but can also be merchants or service providers). <sup>4</sup>	Proprietary token format defined by the issuer.	Format defined by EMVco in the document EMV® Payment Tokenisation Specification - Technical Framework. <sup>5</sup>
They can replace all or only part of the original PAN.	They replace the entire PAN with another identical data. The merchant or acquirers who capture them cannot detect whether it is a PAN or an issuer token.	They replace the entire PAN. An exclusive BIN is used for this.
Compliance with Luhn is optional.	Compliance with Luhn and other validation rules applicable to the PAN is mandatory.	
Depending on the implementation, the token may overlap with the numbering of a real PAN.		The token never overlaps with the numbering of a real PAN.
They can be used in recurring transactions or one-click payments in e-commerce and in face-to-face payments.	They can be used in a single transaction (one-time-use/single use (SU) only) or for multiple transactions (multi-use (MU)). This type of tokens are also often called Virtual Credit Card (VCC) or Virtual Card Number (VCN). <sup>6</sup>	They can be used to initiate both card-present (CP) and card-not-present (CNP) transactions. They must be used in conjunction with a Dynamic Token Cryptogram generated exclusively in each transaction and with a maximum lifetime to avoid replay attacks.
Its use is restricted only to the scope of the entity that generates it. (Acquirer, merchant or service provider).	Its use is limited only to the issuer that generates it.	They can be used in any trade and with any acquirer that supports the model.
Depending on the implementation, the token can be authenticated using the CVV2 of the original physical card.	Each token has its related authentication mechanism (CVV2).	Allows cardholder authentication through techniques linked to the original physical card (CVV2, chip and PIN, chip and signature, etc.).

Source: David E. Acosta, "Mobile payments with digital wallets and tokenization," Advantio, May 2019.

[www.advantio.com/blog/mobile-payments-with-digital-wallets-and-tokenization-how-google-pay-apple-pay-and-samsung-pay-protect-your-card-details](http://www.advantio.com/blog/mobile-payments-with-digital-wallets-and-tokenization-how-google-pay-apple-pay-and-samsung-pay-protect-your-card-details)

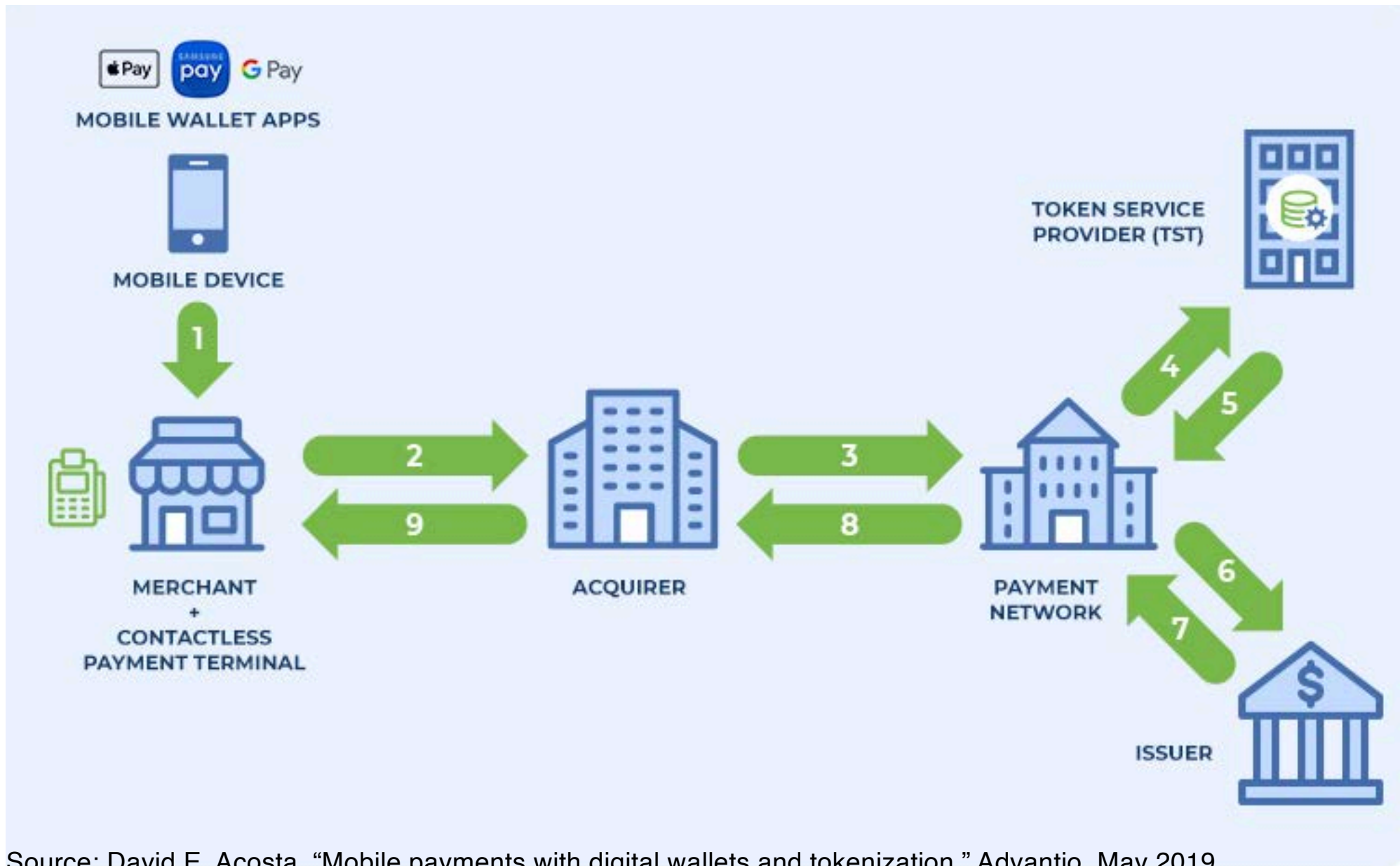
# Payment Token Creation Request



Source: David E. Acosta, "Mobile payments with digital wallets and tokenization," Advantio, May 2019.

[www.advantio.com/blog/mobile-payments-with-digital-wallets-and-tokenization-how-google-pay-apple-pay-and-samsung-pay-protect-your-card-details](http://www.advantio.com/blog/mobile-payments-with-digital-wallets-and-tokenization-how-google-pay-apple-pay-and-samsung-pay-protect-your-card-details)

# Transactional Process for Payments with EMVco Tokens



Source: David E. Acosta, "Mobile payments with digital wallets and tokenization," Advantio, May 2019.

[www.advantio.com/blog/mobile-payments-with-digital-wallets-and-tokenization-how-google-pay-apple-pay-and-samsung-pay-protect-your-card-details](http://www.advantio.com/blog/mobile-payments-with-digital-wallets-and-tokenization-how-google-pay-apple-pay-and-samsung-pay-protect-your-card-details)

# Transaction Flow for ATM via a “Tokenized Card”

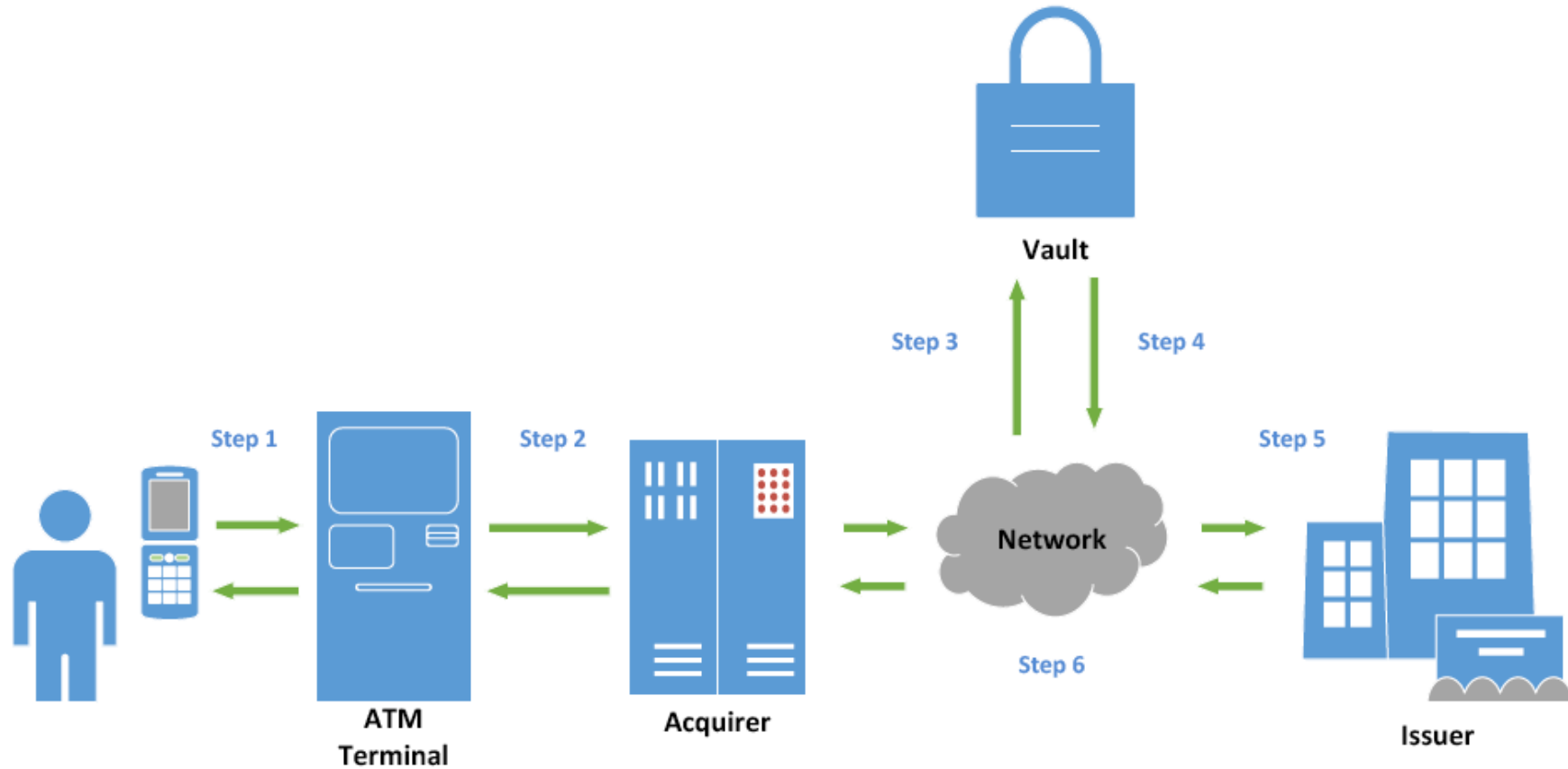


Figure 5. Mobile Device Form Factor (Tokenized) Transaction Flow

# Relationship between Payment Tokens and PCI SSC Standards

Payment Card Industry Data Security Standard (PCI DSS)		Payment Card Industry Token Service Provider (TSP) Security Requirements	
Cardholder Data Environment – CDE	The use of payment tokens is considered outside the scope of PCI DSS when used in conjunction with dynamic cryptograms and domain controls. (Token Domain).	N/A	
Acquirer		N/A	
Token Requestors (TR)		N/A	
Token Service Provider (Token Data Environment – TDE)		Within the TDE, payment tokens must meet the same security criteria applicable to the PAN (PCI DSS). If PAN data exists within the TDE, it must be protected with PCI DSS controls. Outside the TDE, tokens do not require PCI DSS compliance.	The TDE must comply with the 8 security requirements of the PCI TSP standard.
Issuer		Because the issuer requires the original PAN data to authorize the transaction, it requires PCI DSS compliance.	N/A

Source: David E. Acosta, “Mobile payments with digital wallets and tokenization,” Advantio, May 2019.  
[www.advantio.com/blog/mobile-payments-with-digital-wallets-and-tokenization-how-google-pay-apple-pay-and-samsung-pay-protect-your-card-details](http://www.advantio.com/blog/mobile-payments-with-digital-wallets-and-tokenization-how-google-pay-apple-pay-and-samsung-pay-protect-your-card-details)



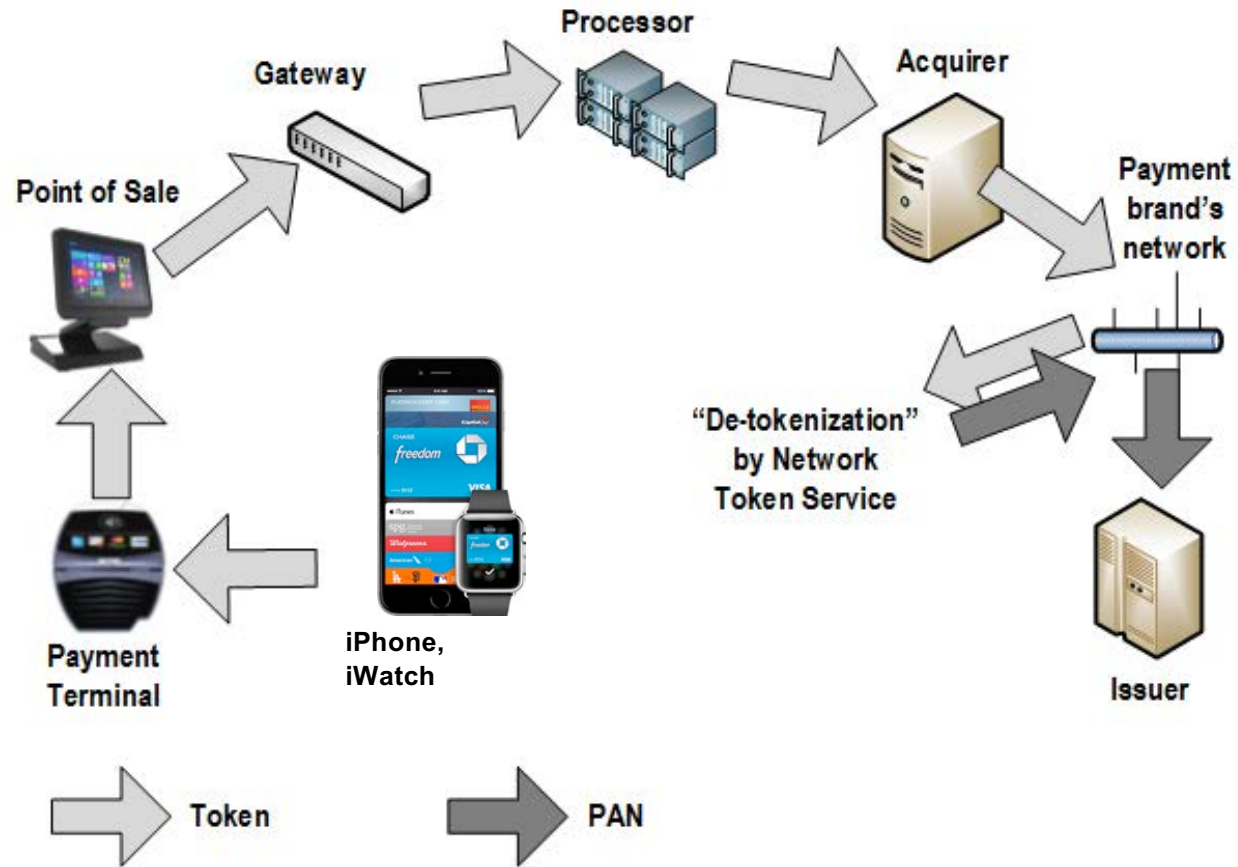
# Tokenization example in Apple Pay

- Apple Pay uses tokenization to remove payment card numbers from the transaction process.
  - ◆ When a user adds a credit card, Apple does not store the actual card number; instead, it creates a “device-only” account number for each card and stores it in the phone’s Secure Element (SE) (which is a chip in the iPhone).
  - ◆ Each time Apple Pay is used, Apple uses a one-time payment number, along with a dynamic security code, essentially creating a one-time card use system and eliminating the need for the static security code (CVV/CVC) on the plastic card.
  - ◆ The merchant never sees the cardholder’s name, card number or security code.

## Tokenization Example in Apple Pay (cont'd)

- For those with privacy concerns: Apple does not collect any transaction data (how much consumers spent, what they bought, etc.).
  - ◆ *“Apple doesn't know what you bought, where you bought it or how much you paid for it. The transaction is between you, the merchant and your bank.”*—Eddy Cue, SVP, Apple
- Note that the Apple Watch also enables payments, but it must be paired with the phone to do so.

# Apple Pay



# Apple Pay

- Apple has reached agreements with:
  - ◆ Card networks: Visa, MasterCard, and American Express, Discover and Union Pay
  - ◆ And most large credit card issuers: BofA, Chase, Citi, AmEx, Wells Fargo, Capital One, U.S. Bank, Navy FCU, USAA, PNC, Barclays, HSBC, HangSeng, BEA, DBS, DahSing, BoC, SC etc.
    - ◆ These issuers represent 83% of U.S. card transaction volume.
    - ◆ Reports indicate that the card-issuing banks have agreed to pay a per-transaction fee to Apple to be included on the phone. These fees to Apple may be offset by the number of transactions that consumers make with Apple Pay, as the banks collect interchange fees (levied on merchants) on all credit and debit card transactions.
  - ◆ Merchants, including (in addition to Apple's own stores): Walgreen's, McDonald's, Disney, Macy's and Bloomingdales, Staples, Subway, Starbucks, Whole Foods, Groupon, Uber, Panera, OpenTable, Tickets.com and many more HK retail stores that accept Credit Cards anyway, even some that did not accept credit card before, e.g. Maxim fast food in HK.

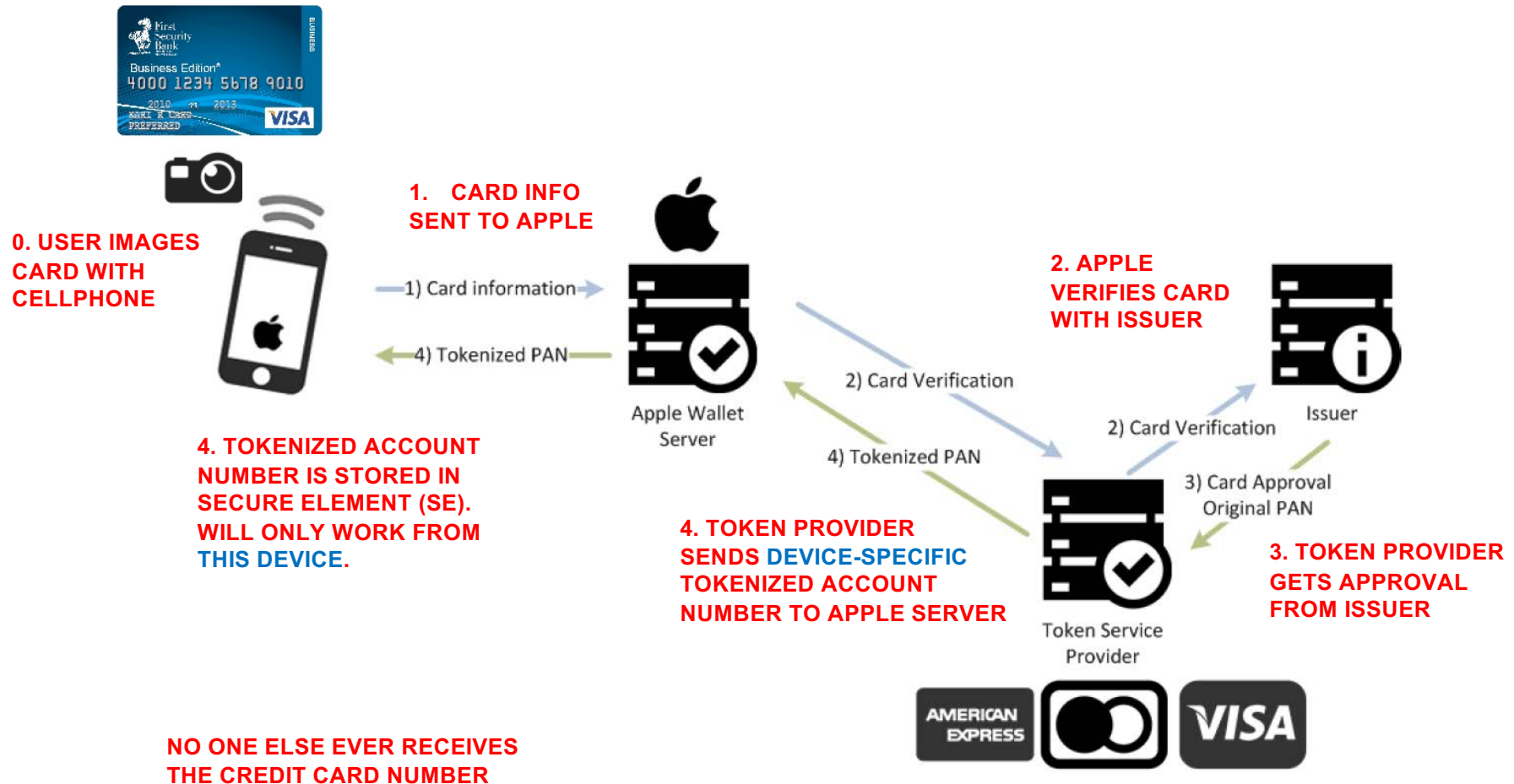
# Apple Pay: Key Properties

Scope and Timing	Apple's Motivation and Value Proposition	Payment Accounts	Completing Transactions	Data and Security
<ul style="list-style-type: none"> <li>• In-Store Payments</li> <li>• Streamlined online payments</li> <li>• Available on iPhone 6, 6 Plus, and Apple Watch since 2015</li> <li>• US Only in October 2014</li> </ul>	<ul style="list-style-type: none"> <li>• Replace physical wallet</li> <li>• Payments will be faster, more secure, and private</li> <li>• Apple's had 46% of market</li> <li>• 5 -10% terminals were NFC enabled</li> </ul>	<ul style="list-style-type: none"> <li>• Add from iTunes account or take a picture of card</li> <li>• Stored as a token on secure element of device</li> <li>• Use via Passbook app</li> </ul>	<ul style="list-style-type: none"> <li>• In-store: contactless NFC terminals with Touch ID authentication</li> <li>• In-App: integrated via the Apple Pay API with Touch ID authentication</li> </ul>	<ul style="list-style-type: none"> <li>• Data stays with merchant and financial institution</li> <li>• Merchant processes token, not card #</li> <li>• <b>BUT Hardware functionalities on iPhones are locked =&gt; 3<sup>rd</sup> party apps can't access NFC chip to do contactless payment on iPhone: Must go thru the Apple Wallet App !!</b></li> </ul>

# Why Does Apple Matter?

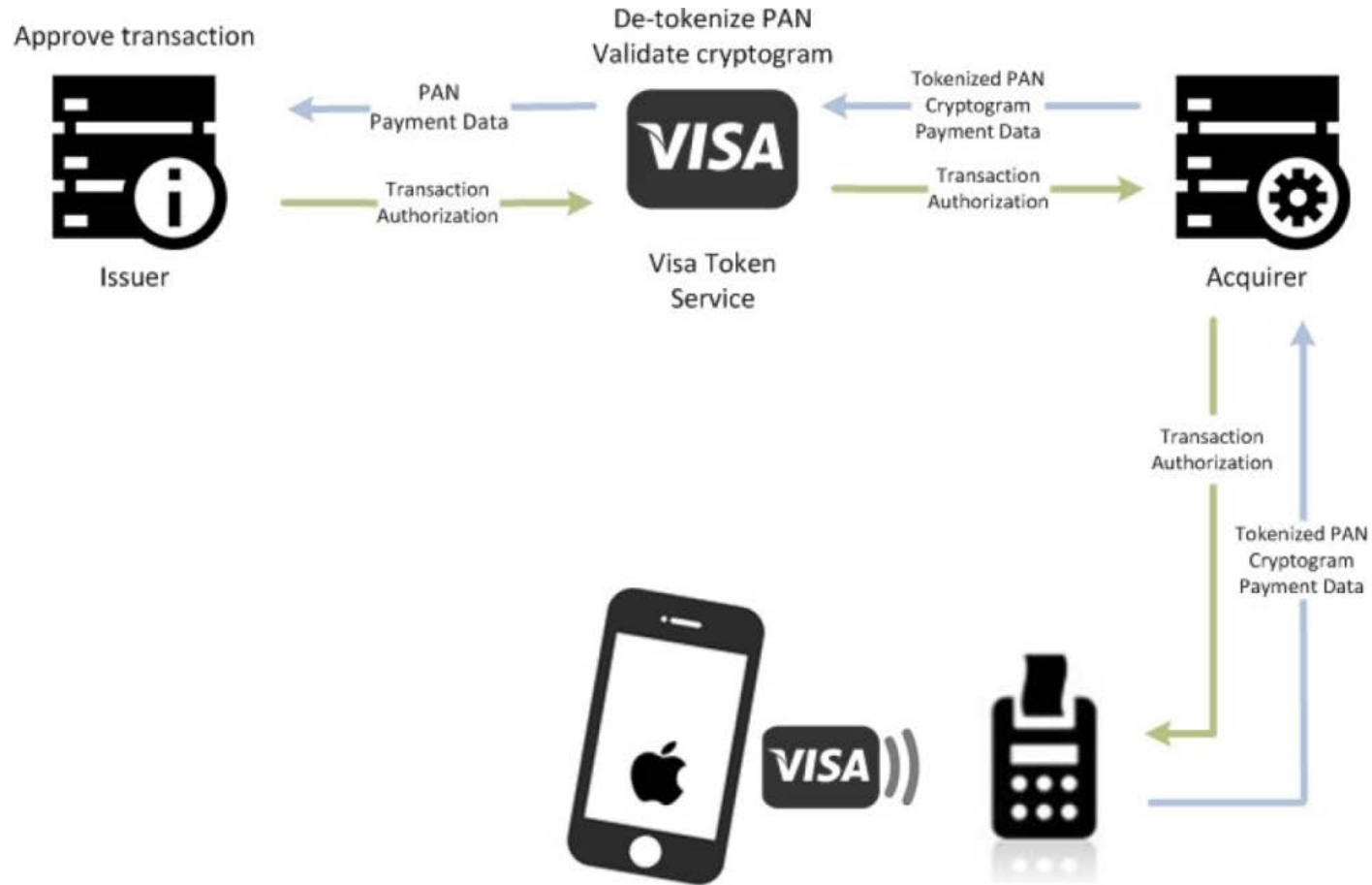
- Widespread consumer acceptance and usage
  - ◆ 10 million devices sold in first 3 days!
  - ◆ 800+ million iTunes accounts already on file
- Leverages existing payments ecosystem and preserves interchange
- Improves payment security = reduces potential fraud
  - ◆ Tokenization
  - ◆ Secure Element (Device number associated with token)
  - ◆ Touch ID authenticates device and card owner

# Apple Pay Enrollment



SOURCE: UNDERWRITERS LABORATORIES

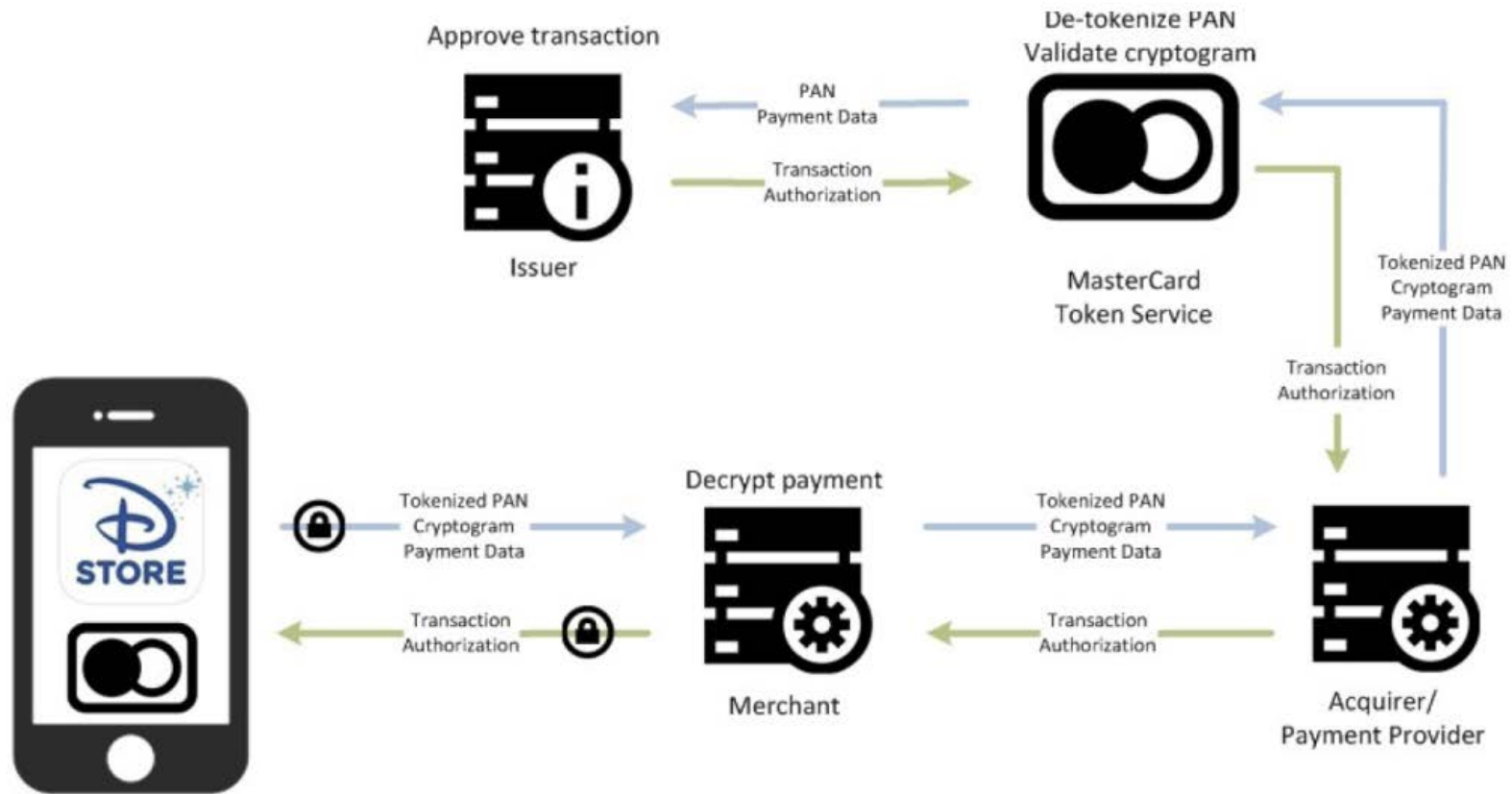
# Apple Pay Proximity Payments



SOURCE: UNDERWRITERS LABORATORIES

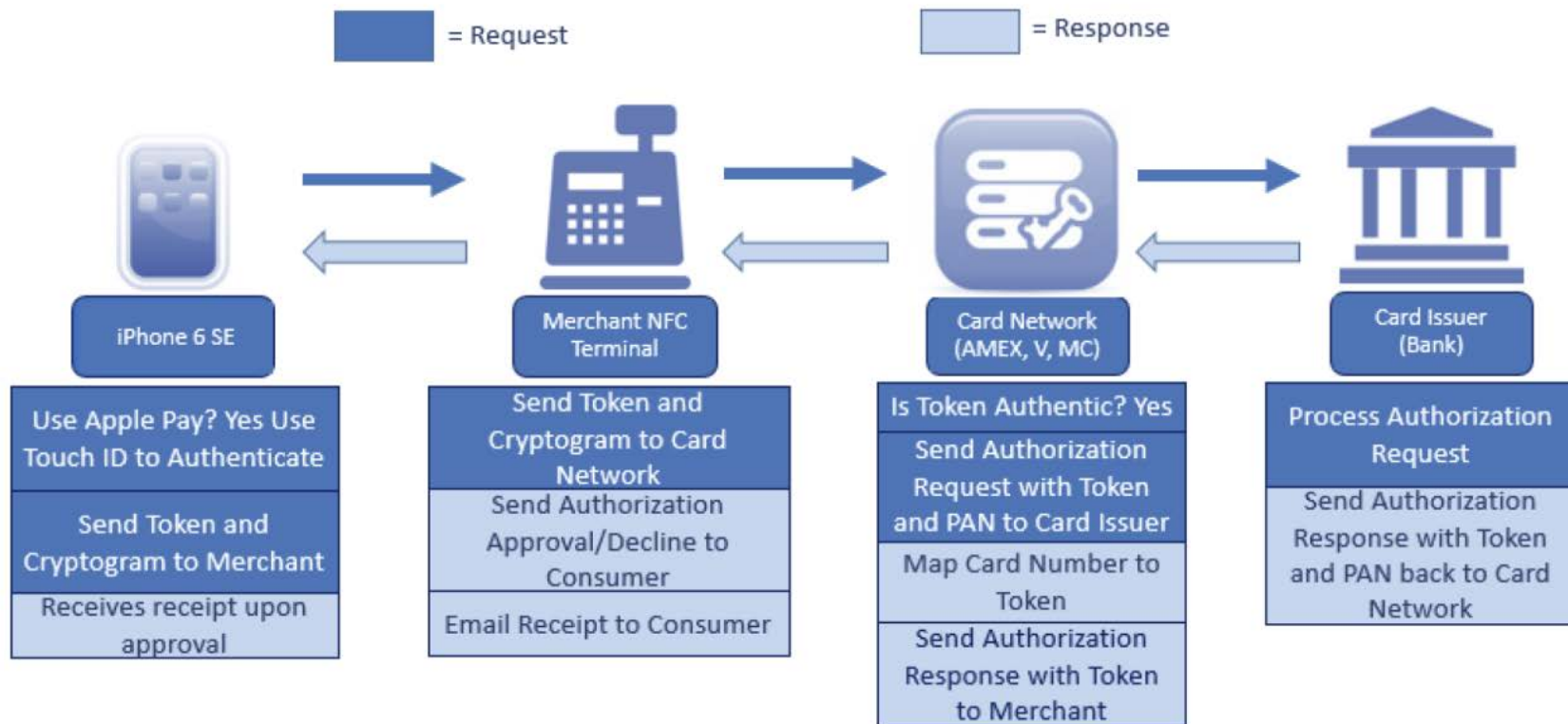


# Apple Pay Remote Payments



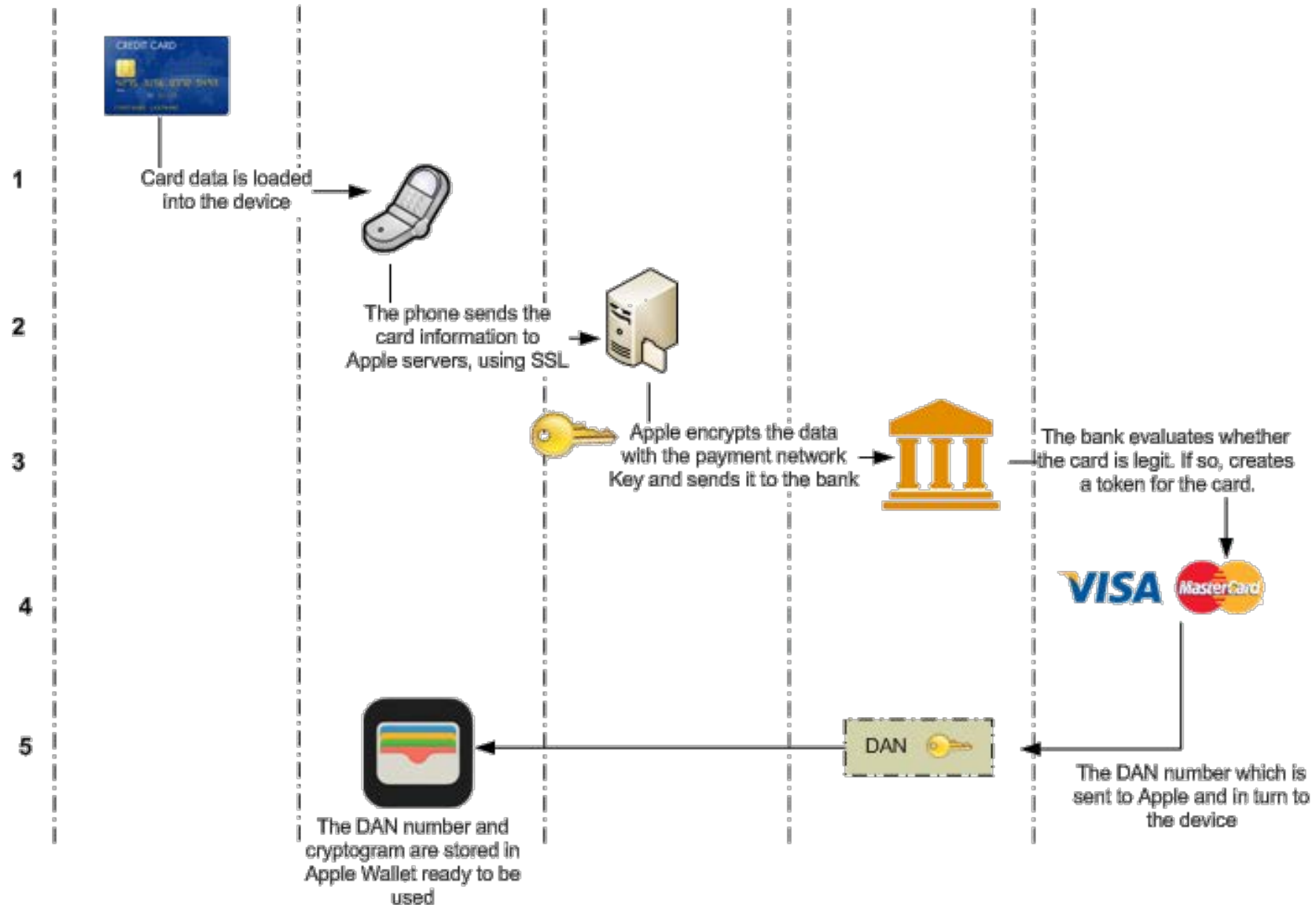
SOURCE: UNDERWRITERS LABORATORIES

# Apple Pay With Fingerprint (Touch ID)

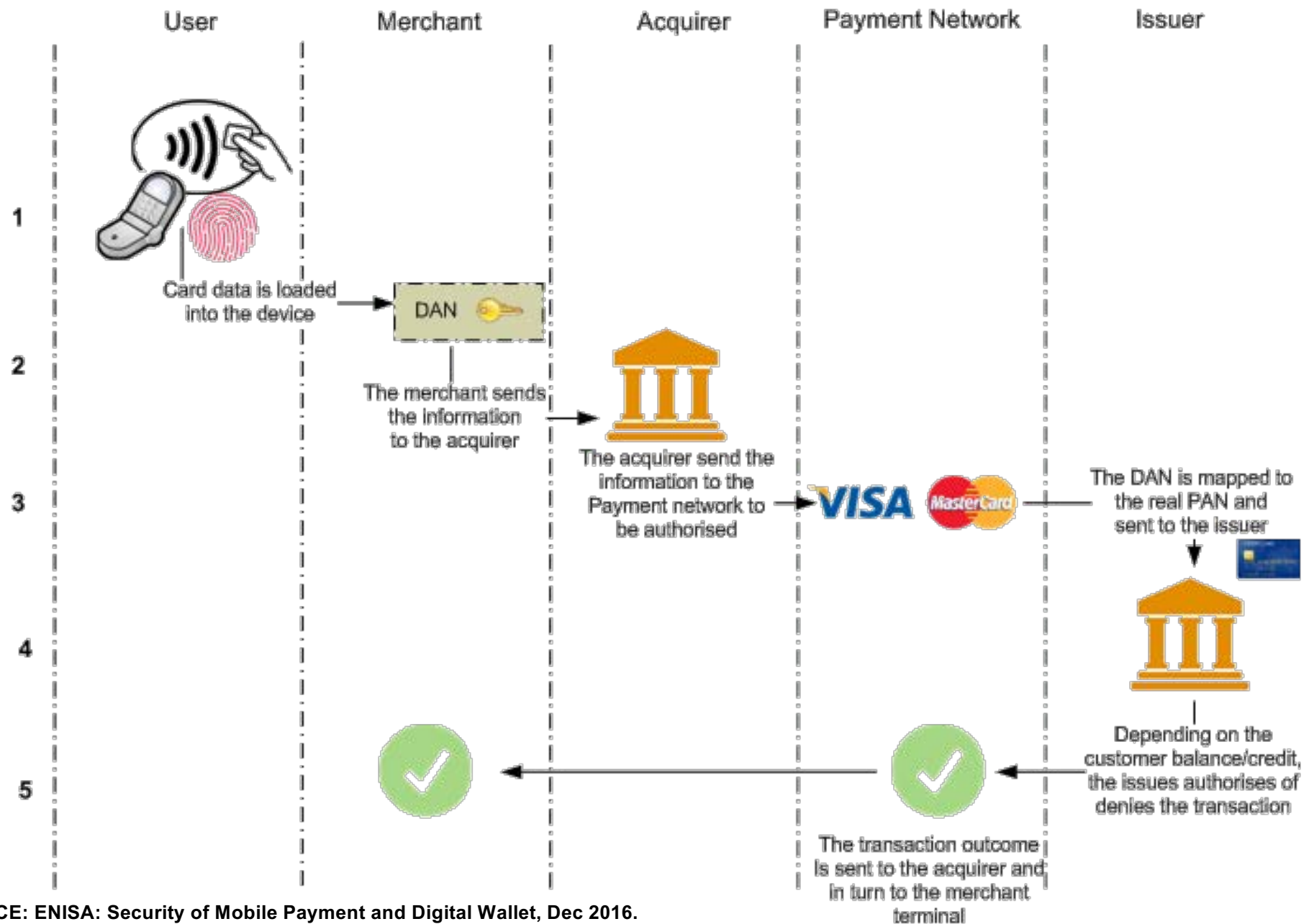


SOURCE: W. CAPRA CONSULTING

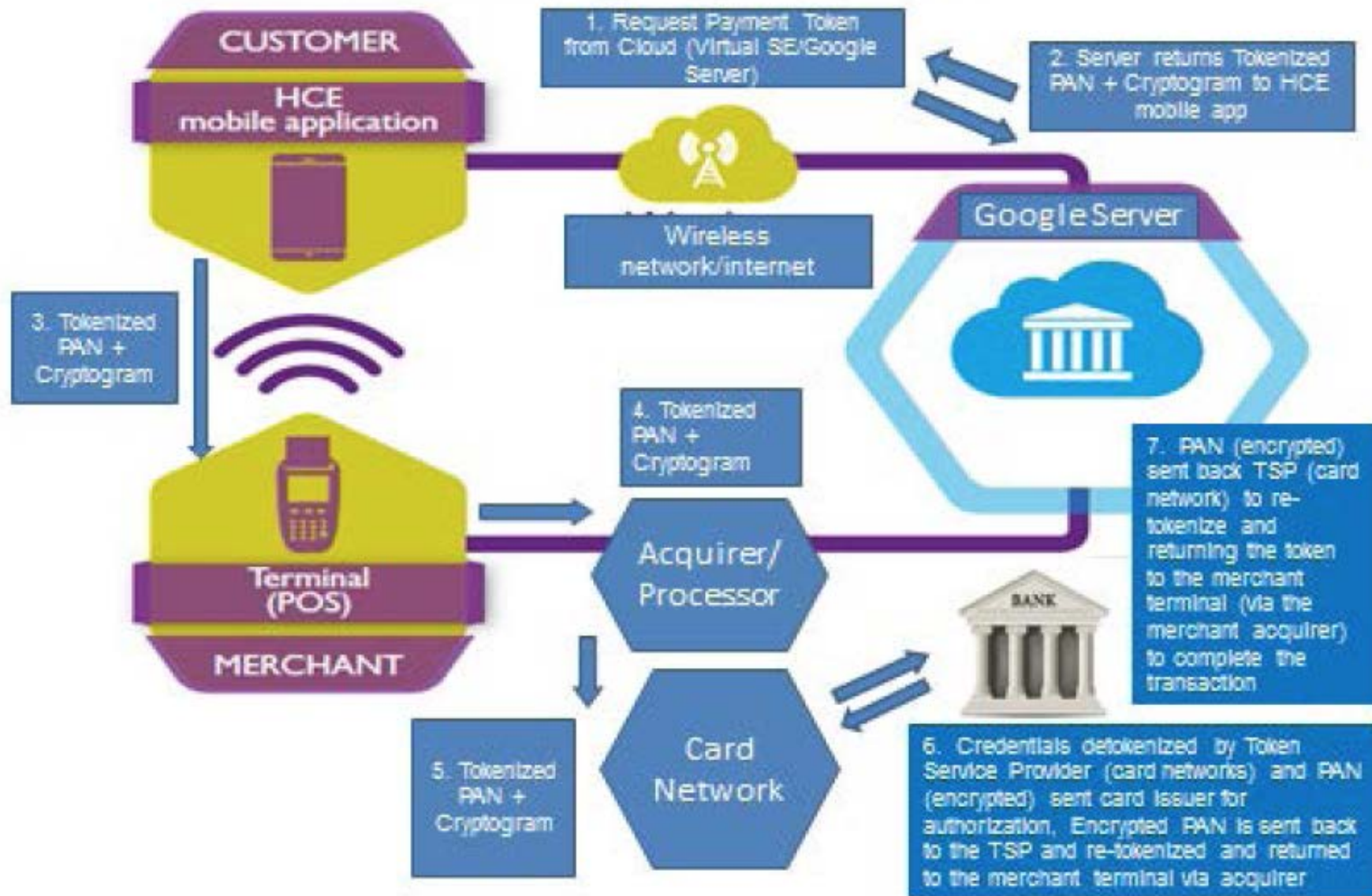
# Apple Pay Card Enrollment Process



# Apple Pay Payment Process

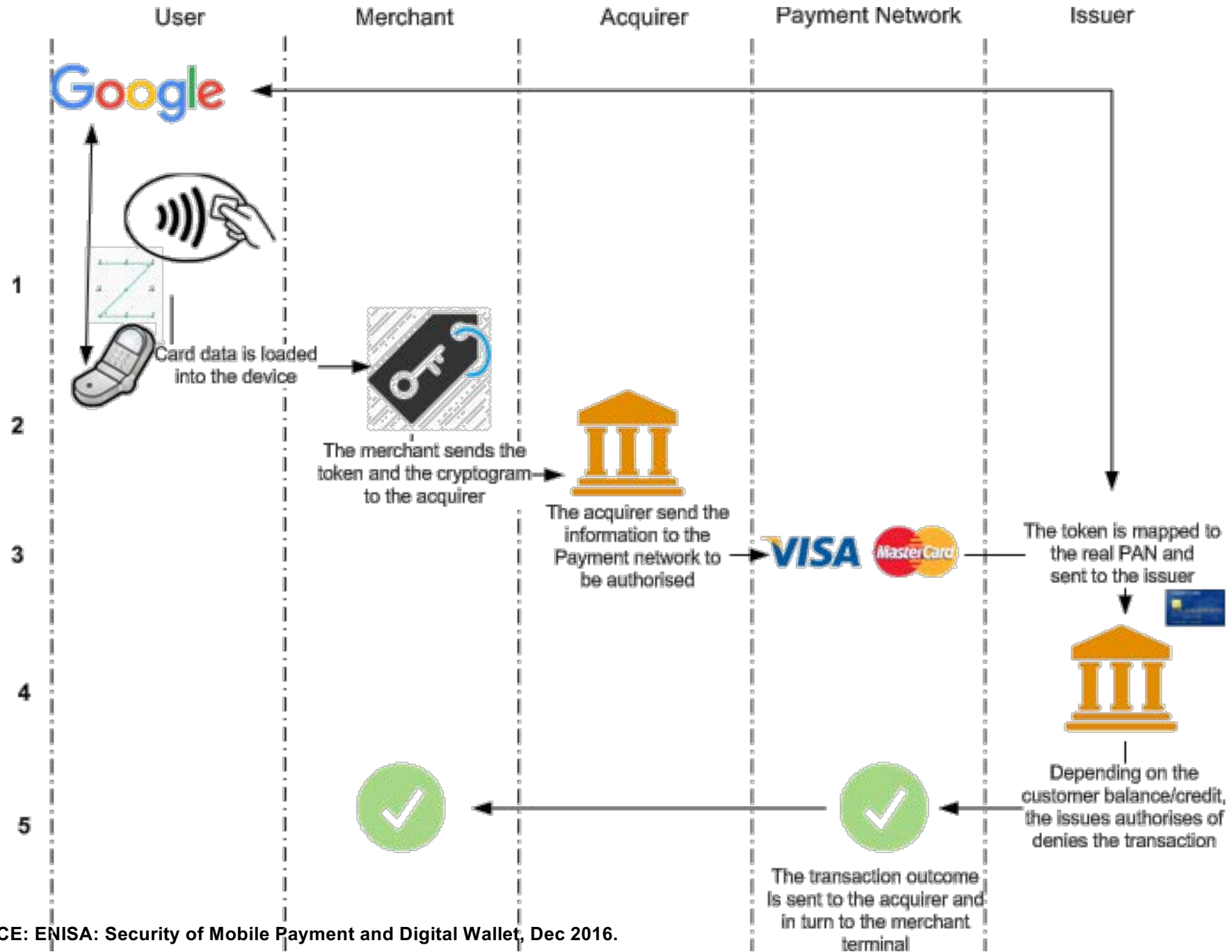


# HCE-based Payment Token Provisioning and Transaction Flow in Google Pay

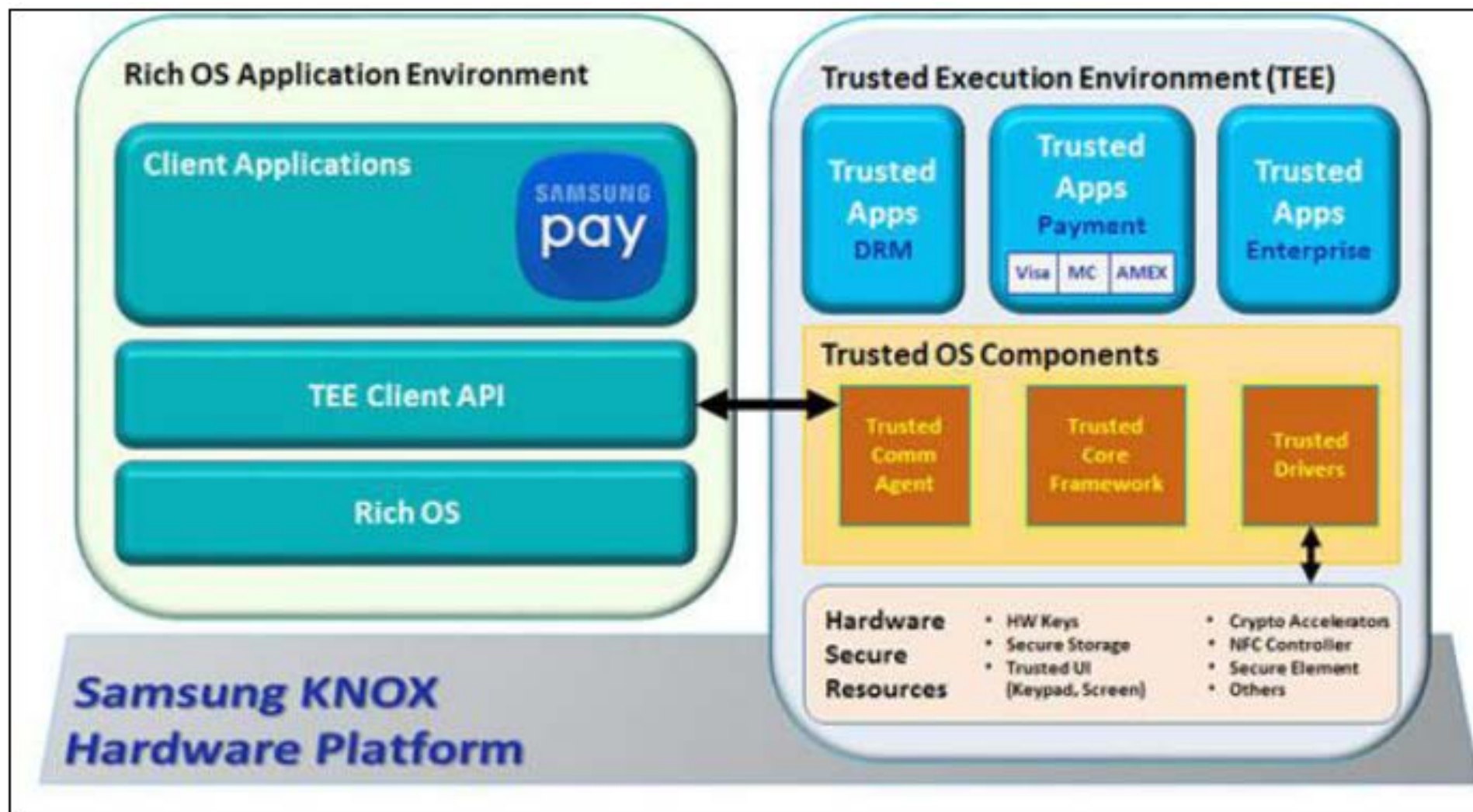


Source: FIME. (2015, August). *The NFC security quiz 2.0: Updated with HCE & tokenization*. Retrieved from <https://www.fime.com/?/WhitePaper/view/7> as modified by the Federal Reserve Bank of Boston.

# Google Pay Payment Process

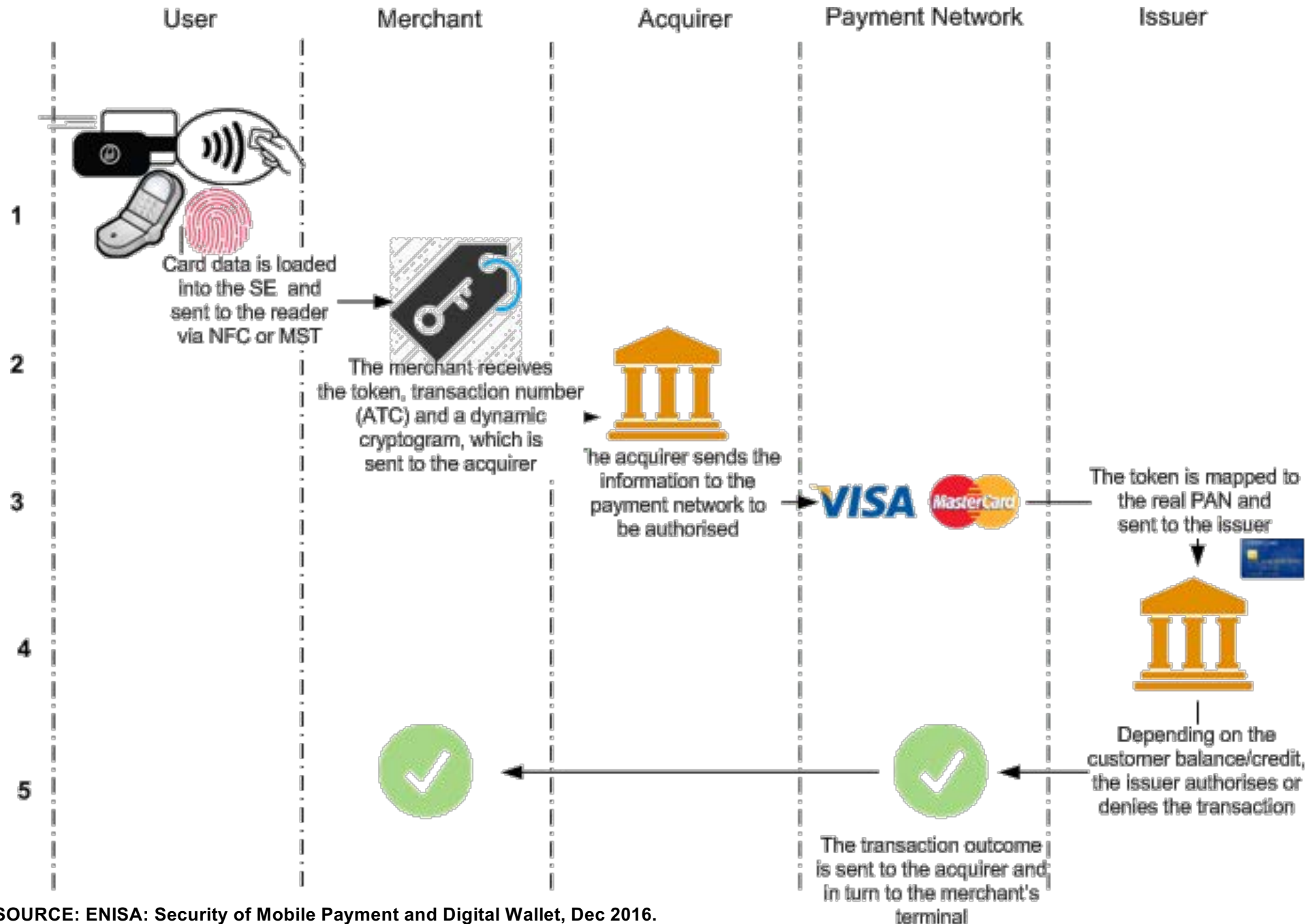


# Samsung Pay HCE System Architecture: TEE + Samsung Knox



Source: <http://developer.samsung.com/tech-insights/pay/device-side-security>

# Samsung Pay Payment Process





# Comparison of Apple/ Samsung/ Google Pay

	Apple Pay	Samsung Pay	Android Pay
<b>Launch date</b>	September, 2014	September, 2015	September, 2015
<b>Supported phones</b>	iPhone 6, 6 Plus and later	select high-end Galaxy phones	all Android 4.4+ phones with NFC
<b>Supported countries</b>	US, UK	US, Korea	US
<b>Upcoming countries</b>	China - Q1 2016 EU countries - Q1 2016	UK - August 2016 Spain, China - Q1 2016 Australia, Brasil, Singapore	No data
<b>Type</b>	NFC only	NFC Magnetic (MST)	NFC only
<b>Shortcut to launch</b>	Starts automatically when near NFC terminal	Swipe up from bottom of screen	Starts automatically when near NFC terminal
<b>Does it work with traditional terminals?</b>	-	✓	-
<b>Does it work with NFC terminals?</b>	✓	✓	✓
<b>Does it work with ATMs?</b>	-	-	-
<b>Does it work for purchases in apps?</b>	✓	-	✓

# Comparison of Apple/ Samsung/ Google Pay

	<b>Samsung Pay</b>	<b>Apple Pay</b>	<b>Google Pay</b>
Compatible devices	Samsung Galaxy phones since the Galaxy Note 5, Gear Watch and Gear Watch Active, Gear S2 and S3	Apple iPhones since the SE, Apple Watch, MacBook Pro with TouchID, iPads since 5th generation, iPad Pro and iPad Mini	Android phones with NFC and HCE support running KitKat (4.4) or higher
Availability (see note below)	24 countries worldwide	41 countries worldwide	29 countries worldwide
Authentication	Fingerprint, PIN or iris	FaceID or fingerprint	Fingerprint, PIN, pattern or password
Where can you use?	Works with NFC, magnetic stripe or EMV terminals, in-app purchases	Works with NFC terminals, in-app purchases and web purchases in Safari	Works with NFC terminals, in-app and web purchases
Cards	Credit, debit, loyalty and gift cards	Credit, debit and loyalty cards	Credit, debit, loyalty and gift cards
Which banks?	Wide variety of banks: full list here; PayPal	Wide variety of banks: full list here	Wide variety of banks: full list here; PayPal

# Digital Wallet Users Could Double by 2020

Estimated number of digital wallet users worldwide (in millions)



2018 2020

Source: Juniper Research



# Market Share Prediction of Apple Pay vs. Google Pay vs. Samsung Pay

## US Proximity Mobile Payment Users, by Platform, 2017-2022

*millions*

	<b>2017</b>	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
Starbucks	20.7	23.4	25.7	27.6	28.8	29.8
Apple Pay	19.9	22.0	24.0	25.5	26.6	27.5
Google Pay	9.3	11.1	12.4	13.4	14.3	14.9
Samsung Pay	8.4	9.9	11.0	11.9	12.7	13.2

*Note: ages 14+; mobile phone users who have made at least one proximity mobile payment transaction in the past 6 months*

*Source: eMarketer, May 2018*

## Companies From Six Different Industries are Influencing the Mobile Payments Conversation



# Starbucks mobile App

User must reload the amount to exclusive Starbucks card to purchase coffee

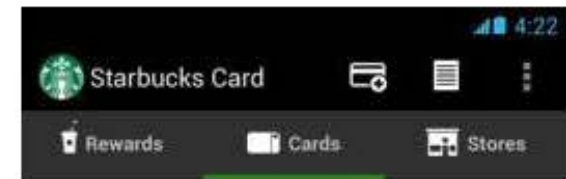
User can use PayPal account to reload the Starbucks card

User can attach a credit card to the account to reload the Starbucks card

User can tip the barista through the app digitally

It is primarily a loyalty app that supports payment

Over 1 million downloads



# Players in mobile wallet race (circa 2014)

## Technology Company Driven

Logos included in this category: Google, Apple, Level Up, Square, Corfire, DWOLLA, MOBILIS, fiserv, PAY, paycloud, ShareItPay, fon, ROAM, tracknose, tabbedout, CLINKLE, VOITUS, GO Now, Clutch, boku (Pay by Mobile), freebee pay, CARDFREE, appMobi, PayApp, PLACECAST, PassKit, venmo, iMOCU, PRE CASH, Loop, ACCELITEC (WalletBuilder), coinbase, sequent.

## Retailer And Merchants Driven

Logos included in this category: STARBUCKS COFFEE, DUNKIN' DONUTS, BURGER KING, MCX (MERCHANT CUSTOMER EXCHANGE).

## Financial Services Driven

**Banks, FI's**

Logos included: Wells Fargo, usbank, Chase, Moven, backyard.

**Payment Processing**

Logos included: V.me by Visa, Verifone, paypass, Lemon, kuapay, FIS, vantiv, YESpay, tyfone, pulse, WINCOR NIXDORF, hyperwallet, APRIVA, MAGTEK.

## Mobile Carrier Company Driven

Logos included: at&t, T-Mobile, verizon, ISIS, Sprint.

## Other major US-based Initiatives in Mobile Wallets/ Payments

*(Failed) Softcard (previously Isis Mobile Wallet) (Nov 2010- Mar 2015):*

- Joint venture of big telecom providers: AT&T, Verizon, T-Mobile
- Nation-wide service launched in Nov 2013
- Discontinued service in Mar 2015; founders pledged support for Google Pay instead
- Softcard assets acquired by Google later in 2015.

*(Failed) CurrentC mobile wallet by MCX (Aug 2012 – Mar 2017):*

- Merchant-driven. Members include 7-Eleven, Southwest Airlines, Wal-Mart, Shell Oil, Sears, Target, Best Buy, etc.
- Use QR code, Bluetooth Low Energy (BLE), Geolocation technologies instead of NFC contactless approach ;
- Bundled mobile payment apps with discount coupons for merchants (like the Starbucks App)
- Pilot Trials in 2015-2016
- Accused of anti-competition acts against Apple/ Google Pay
- Announced to postpone launch indefinitely in May 2016
- Assets purchased by Chase Pay in Mar 2017



## Other major US-based Initiatives in Mobile Wallets/ Payments (cont'd)

*(Partially Failed) Chase Pay (Owned by JP Morgan Chase Bank)*

- Service announced in 2015
- Key Selling point to Merchants: lower transaction fees for merchants when comparing to Apple/Google/Samsung Pay as well as Credit card payments
  - ◆ This is made possible by Chase's deal with Visa to acquire part of the VisaNet (now called ChaseNet) to directly process transactions of Chase issued Credit/Debit cards
- Previously, it supported both Mobile Payment (using QR code via the Chase Mobile Wallet App) for Physical retail store purchases as well as online in-app/ website payments
- **Discontinued** Chase Mobile Wallet App in late 2019 to focus online in-app/site payment for merchants instead, i.e. **do not support physical retail-stores payments anymore !**

## Other major US-based Initiatives in Mobile Wallets/ Payments (cont'd)

### *Paypal (since Dec 1998):*

- Mainly focus on supporting online shopping and P2P payments via in-app/website payment option for merchants using Paypal
- Users can refill Paypal account via credit-card or by linking it to the their bank account (and then conduct transfer using ACH)
- Users can link Paypal account with Google Pay (instead of linking to a credit card) to enable physical retail store purchases
- Main revenue sources: help Merchants to receive payments in a user-friendly, yet cost-effective manner (as comparing to get paid via credit cards)
- Also provide other payment management services, e.g. fraud detection, seller protection, financial reporting. Paypal also offers a Mobile Point-of-Sale services for Merchants to receive credit-card, Google/Apple/Samsung Pay payments at physical stores
- Paypal also acquired Venmo, an Online Social Networking Payment startup via its purchase of Braintree in 2013. Venmo focuses on sending \$ or split bills between **friends & families** ; Users must not use Venmo for goods/ service purchases online or offline.

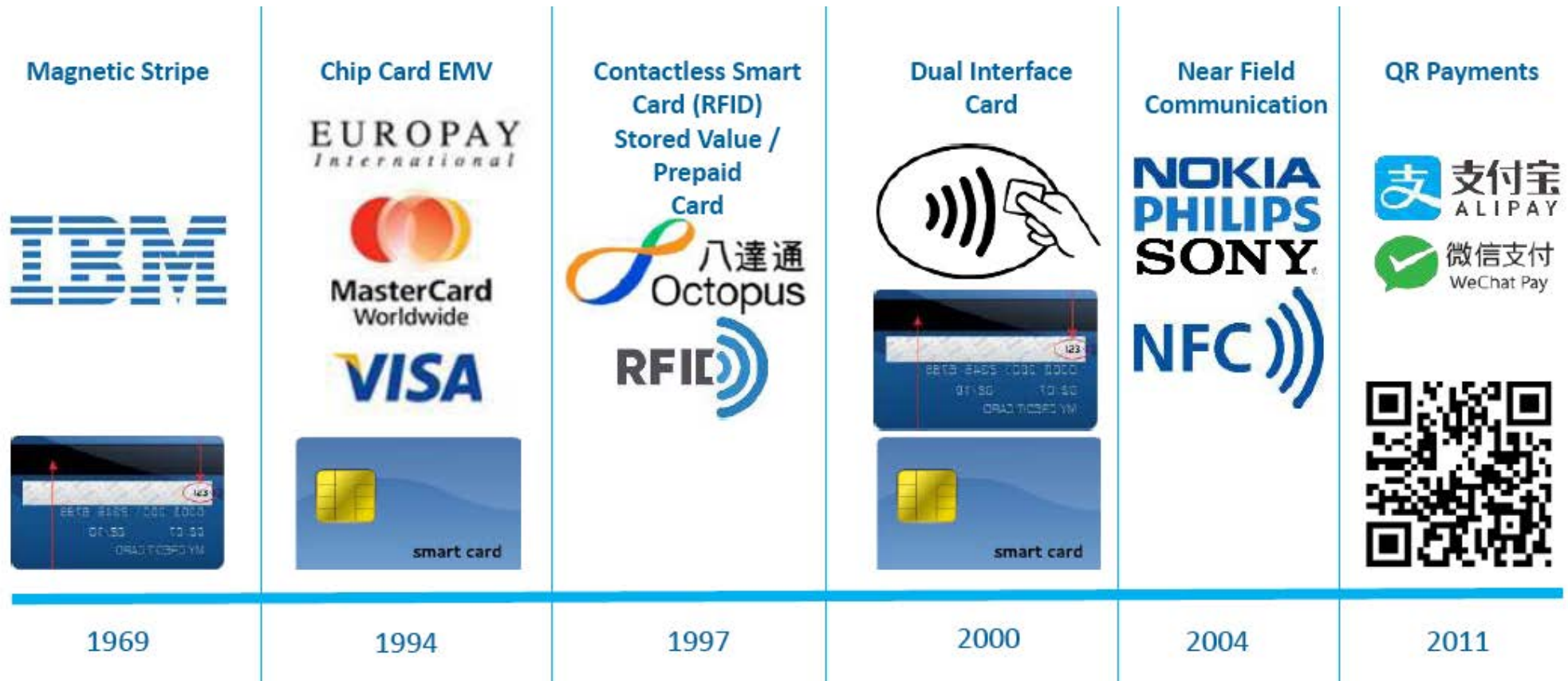
More on Paypal in later part of this course

## Other major US-based Initiatives in Mobile Wallets/ Payments (cont'd)

### *Amazon Pay (since 2007):*

- More like Paypal to focus on online shopping/checkout purchases by letting its customers to pay for goods and services of external merchant websites/mobile-apps with their Amazon accounts
- Also had a 6-month trial of Amazon Mobile Wallet for physical retail purchases between 2014 to 2015 but did not continue after the trial
- Opened its first Cashierless “Amazon Go Grocery” in Seattle in Feb 2020
  - ◆ Customers just present their QR code from an Amazon Mobile App for scanning upon entering the store, picking up the goods they want and then leave
    - ✦ <https://www.mobilepaymentstoday.com/news/amazon-debuts-first-go-grocery-store/>
- Started to sell Just-Walk-Out, the set of Cashierless Technologies Amazon developed for its own Go Grocery stores to other brick-and-mortar retailers since early 2020 ; <https://www.reuters.com/article/us-amazon-com-store-technology/amazon-launches-business-selling-automated-checkout-to-retailers-idUSKBN20W0OD?feedType=RSS&feedName=technologyNews>
  - ◆ US Retail Union claimed this will eliminate 16 million retail jobs
  - ◆ <https://www.mobilepaymentstoday.com/news/retail-union-group-calls-amazon-tech-a-trojan-horse-aimed-at-grabbing-customer-data/>

# Payment Media Evolution



# Comparison of Wireless POS/ Beacon technologies

	BLE	BLE Beacon	Bluetooth Classic	Geolocation	QR Code	NFC	WiFi
Underlying technology or standard and frequency	Bluetooth 4.0 2.4 to 2.485 GHz	Bluetooth 4.0 2.4 to 2.485 GHz	Bluetooth 4.0/4.1 2.4 to 2.485 GHz	Global Position / Geodesy via satellites	ISO/IEC 18004:2006 2D matrix code or bar code	ISO/IEC 14443 ISO/IEC 18092 13.56 MHz	Near Field 2.4 GHz/ 5GHz Microwave
Range	~50 to 150 m	~1 cm to 150 m	~10-100 m (based on radio class)	Outdoor satellite range	~10 cm	<10 cm	~650 m
Network requirement during transactions	NA	Need data channel to redeem content	NA	No	Needed for dynamic data population	No. Needed during provisioning of credentials <sup>3</sup>	No
Connection speed (sec)	~0.03	~0.03	~1	NA	NA	~0.1	~0.03
Use/payload/transfer rate	Data transfer ~300 kbps	Data transfer ~300 kbps	Data transfer up to ~25 Mbps in 4.0	Location identification/ coordinates	Data transfer rate based on scanner Numeric chars 7089 in QR code version 40	Data transfer, contactless payment credentials ~424 kbps	Data transfer up to 250 Mbps
Use cases	Location ID, hands-free payment, promotions, offers	Consumer recognition and promotion, localization in store	Pairing with PDAs, printers, PC accessories, headsets, smart devices	Device ID, location monitoring and tracking	Tracking, ID, payments, marketing, Web site login	Contactless payment, access, transit, ID, coupons	Data transfer, payment, network access



# NFC vs. Cloud vs. QR Code






Technology	Strengths	Weaknesses	Notable deployments
QR code	<ul style="list-style-type: none"><li>• Works on almost all OS and devices</li><li>• Low upfront costs</li><li>• Leverage existing imaging solutions at POS</li></ul>	<ul style="list-style-type: none"><li>• Generally weaker security</li><li>• Lack of standards</li><li>• Not recognized form of payment</li><li>• Easily erasable, and damageable</li></ul>	<ul style="list-style-type: none"><li>• Starbucks</li><li>• LevelUp</li><li>• Dunkin Donuts</li><li>• Apple Passbook</li></ul>
Cloud	<ul style="list-style-type: none"><li>• Leverage existing payment terminals</li><li>• No consumer device required</li><li>• Low upfront costs</li></ul>	<ul style="list-style-type: none"><li>• Limited provider choices</li><li>• Trust issues could inhibit adoptions</li><li>• Strong association with online channels</li></ul>	<ul style="list-style-type: none"><li>• Home Depot (PayPal)</li><li>• Hollister (PayPal)</li><li>• Jos. A Bank (PayPal)</li><li>• Lemon wallet</li></ul>
NFC	<ul style="list-style-type: none"><li>• By 2015, more than 25% of the phones are NFC enabled</li><li>• Easy product integration</li><li>• New technology</li></ul>	<ul style="list-style-type: none"><li>• Users have not yet accepted as a standard payment method</li><li>• Not available on all phones</li></ul>	<ul style="list-style-type: none"><li>• ISIS mobile wallet</li><li>• Google wallet</li><li>• Orange Money</li><li>• Boku mobile wallet</li></ul>

# Mobile wallets by type (circa 2014)



Wallet Name	NFC	QR Code	Other
Allied wallet	✓		
PayPal			✓
Bank of America mobile wallet		✓	
Paydiant mobile wallet			✓
Boku Mobile Wallet	✓		
Ericsson Wallet Platform			✓
Firethorn Pay			✓
FIS Mobile wallet			✓
Google Wallet	✓		✓
Isis Mobile Wallet	✓		
Lemon Wallet			✓
Level UP		✓	
Apple's Passbook		✓	✓
Square		✓	✓

# Payment Media Standards supported by Different Payment Card Networks

No	Brand	Standard Maintainer Organization	Operator Organization	Origin Country	Transaction Scope	Chip Card Standard	Contactless Standard	Interbank Fund Transfer	QR Code Standard
1	 UnionPay	China UnionPay (CUP) (Zhōngguó Yīnlián), Est 2002	China UnionPay	China	Domestic Intl' supported via other payment network	PBOC 2.0/3.0	QuickPass	CUP (ISO8583 Based)	Alipay WeChat Pay UnionPay QR Code
2	 RuPay	National Payments Corporation of India (NPCI), Est. 2008	National Financial Switch (NFS), Est. 2004	India	Domestic Intl' supported via other payment network	RuPay EMV	RuPay Contactless	UPI & IMPS (XML API front end with ISO8583 back end)	Bharat QR
3	 GPN	Asosiasi Sistem Pembayaran Indonesia (ASPI)	Rintis, Artajasa, Jalin, Alto (RAJA), Est. 2017	Indonesia	Domestic	NSICCS	UNIK	GPN (ISO8583 Based)	N/A
4	 Visa	Visa Inc, Est. 1958	Visa Inc	USA	International	EMV	payWave	N/A	mVISA (EMVCo)
5	 MasterCard	MasterCard Inc, Est. 1966	MasterCard Inc	USA	International	EMV	Paypass	N/A	Masterpass QR (EMVCo)

PS: Other Card Payment Network are not listed in this table are American Express, Discover, JCB, Diners Club, BC Card



# Evolution of QR Code Payment Technologies

Country/Org	2011	2016	2017	Interoperability
China	AliPay WeChat Pay	UnionPay	PBOC Regulating QR Payment	No national standard and interoperability
India		NPCI, MasterCard, Visa creates National QR Standard – Bharat QR	PayTM, Retail Bank	Guaranteed via Bharat QR Standard
Indonesia			DIMO Pay Gojek QR PayPro OVO	No national standard and interoperability
EMV			EMVCo QR	EMVCo QR is loosely regulated standard and provides general transaction flow, basic data types, data elements, However detail implementation will vary between EMVCo implementation

# QR Code Payment Specifications/ “Standards”

## ■ EMVCo

- ◆ Loosely regulated standard, strict adherence is not required, white label friendly

## ■ mVISA

- ◆ Highly regulated standard, strict adherence, copyrighted standard

## ■ Masterpass QR

- ◆ Highly regulated standard, strict adherence, copyrighted standard

## ■ HKMA Common QR code Spec

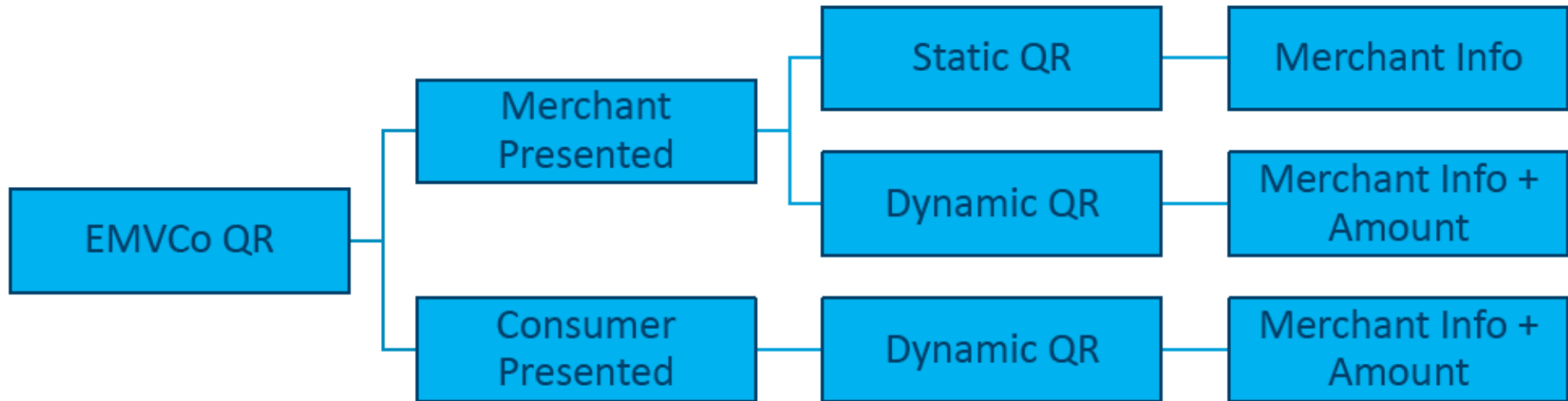
- ◆ based on EMV QRCPS Merchant-Presented QR code

## ■ Alipay, WeChat Pay, UnionPay QR codes

- ◆ Proprietary specifications ; No national standards for interoperability

SOURCE: MITSUBISHI

# EMVCo QR Presentation Mode

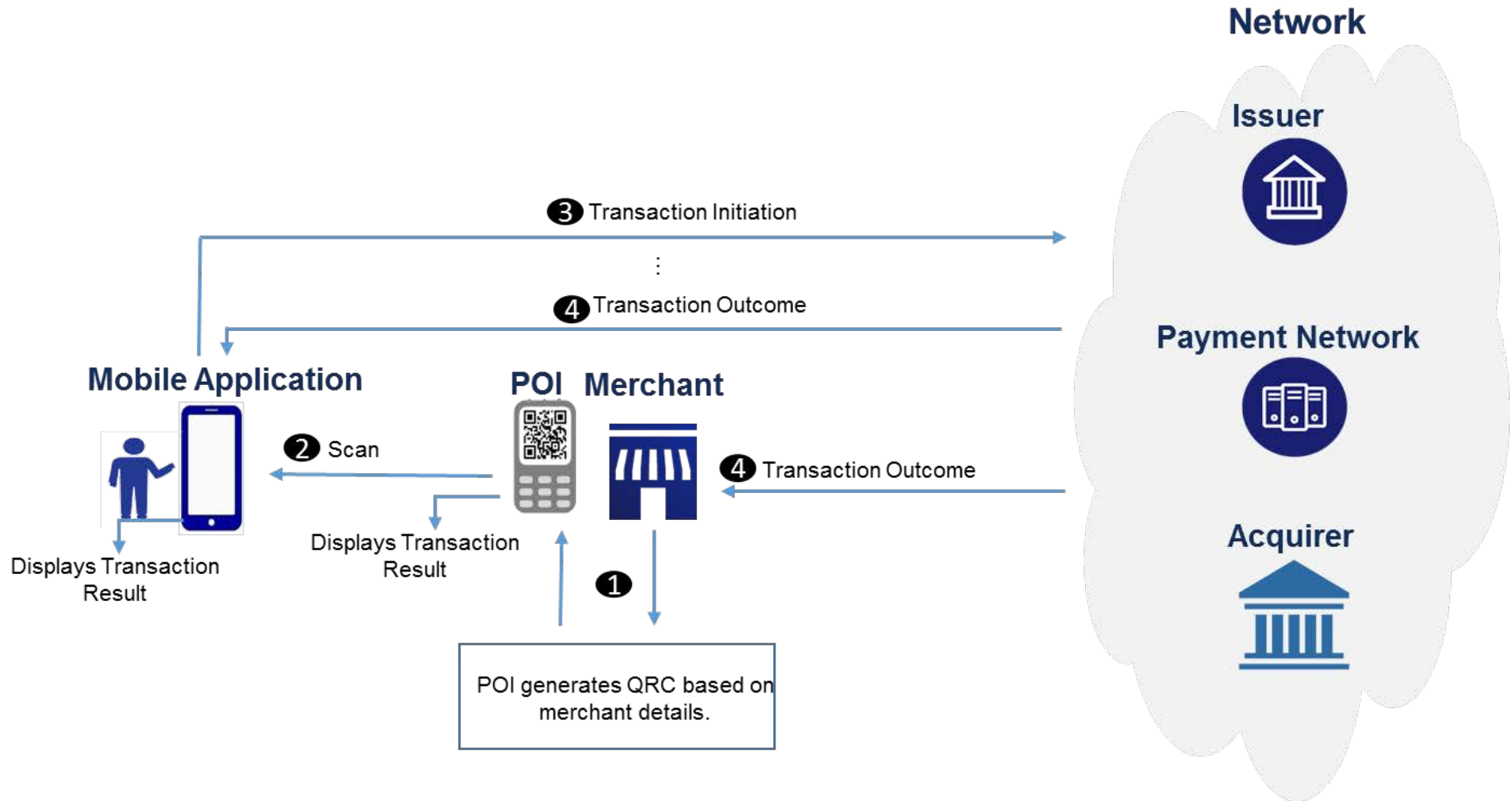


## Merchant Presented Transaction Detail

Merchant Information	Transaction Value	Additional Objects
Merchant Account Information Merchant Category Code Country Code Merchant Name Merchant City Postal Code Merchant Information-Alternate Language	Transaction Amount Transaction Currency Tip or Convenience Information	Bill Number Mobile Number Store Label Loyalty Number Reference Label Customer Label Terminal Label Purpose of Transaction

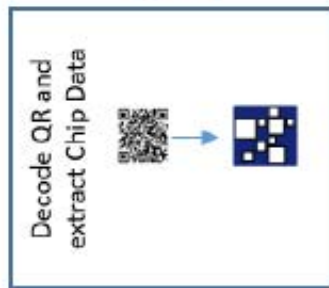
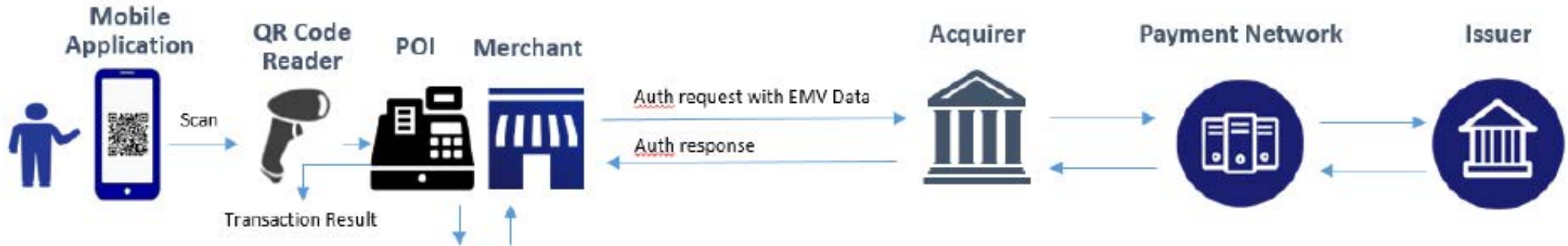



# QR Code Payment Architecture (Merchant-Presented mode)






# QR Code Payment Architecture (Consumer-Presented mode)

**Main Functionality: (on Level1)**

- Scan QR Code
- Convert to string
- Transfer string to POI

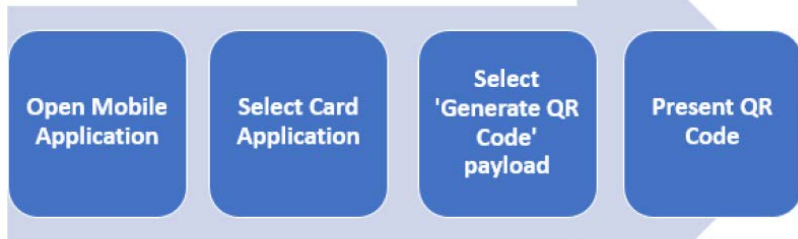
QR Code Reader



**Main Functionality: (on Level2)**

- Base64 Decoding
- Parse Data and Check AID
- Transaction Checkout/Processing
- Construct Auth Message

POI System



# EMVCo QR Code Payload

## EMV QR Code Payload Data Objects

Data Object	Input Characters
Payload Format Indicator	"000201"
Point of Initiation Method	"010212"
CRC	"6304A13A"

Data Object	Input Characters
MCC	"52044111"
Country Code	"5802CN"
Merchant Name	"5914BEST TRANSPORT"
Merchant City	"6007BEIJING"
Language Template	"6420"
<ul style="list-style-type: none"> <li>Local Language</li> <li>Merchant Name—Alternate Language</li> <li>Merchant City—Alternate Language</li> </ul>	<ul style="list-style-type: none"> <li>"0002ZH"</li> <li>"0104 最佳运输"</li> <li>"0202 北京"</li> </ul>

Data Object	Input Characters
Transaction Amount	"540523.72"
Transaction Currency	"5303156"
Tip	"550201"



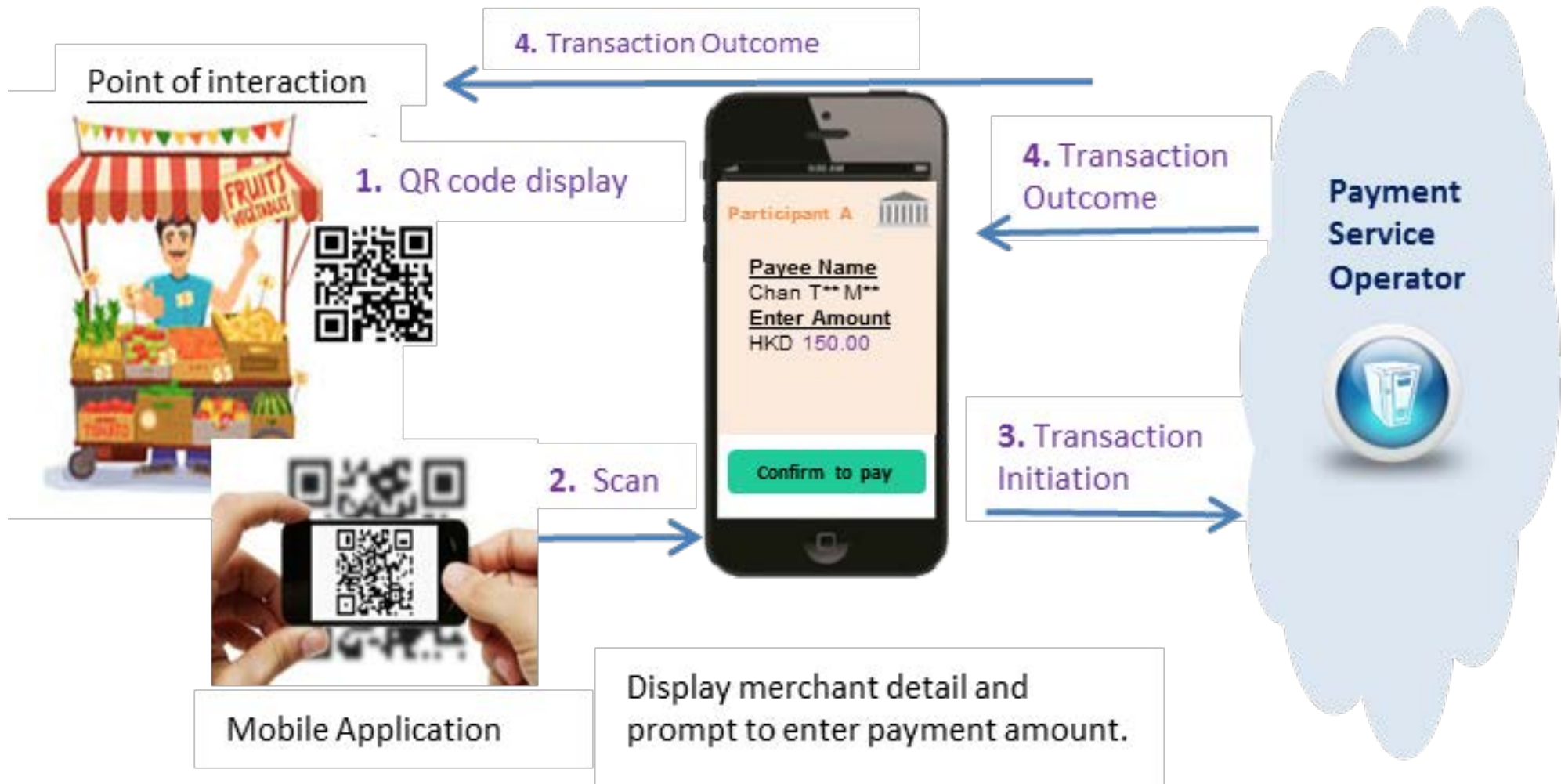
## EMVCo Encoded Information

```
"00020101021229300012D156000000000510A93FO3230Q31280012D156000000010
30812345678520441115802CN5914BEST
TRANSPORT6007BEIJING64200002ZH0104最佳运输0202北京
540523.7253031565502016233030412340603***0708A60086670902ME91320016A01
12233449988770708123456786304A13A"
```

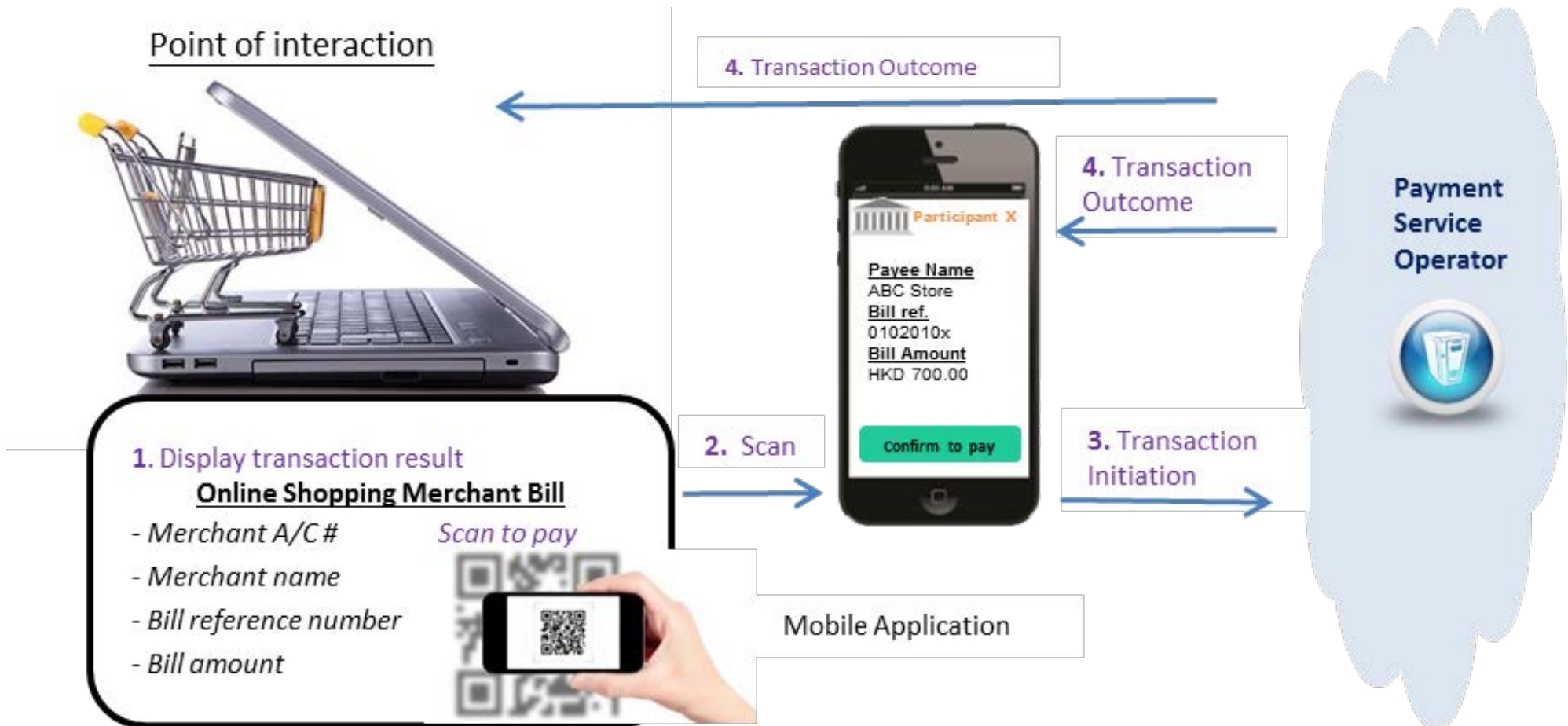
## EMV QR Code



# Static QR Code Merchant payment

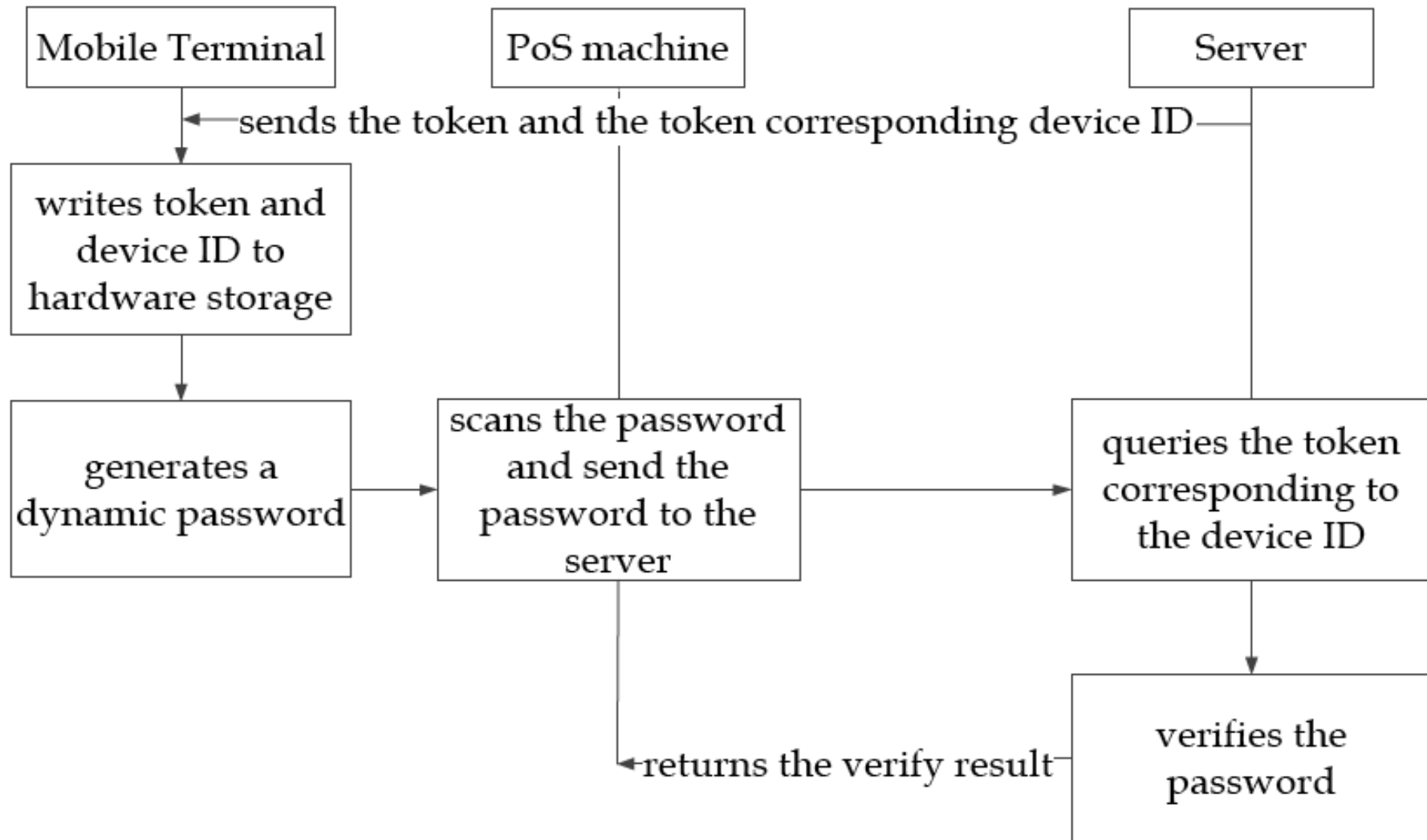


# Dynamic QR Code Online shopping



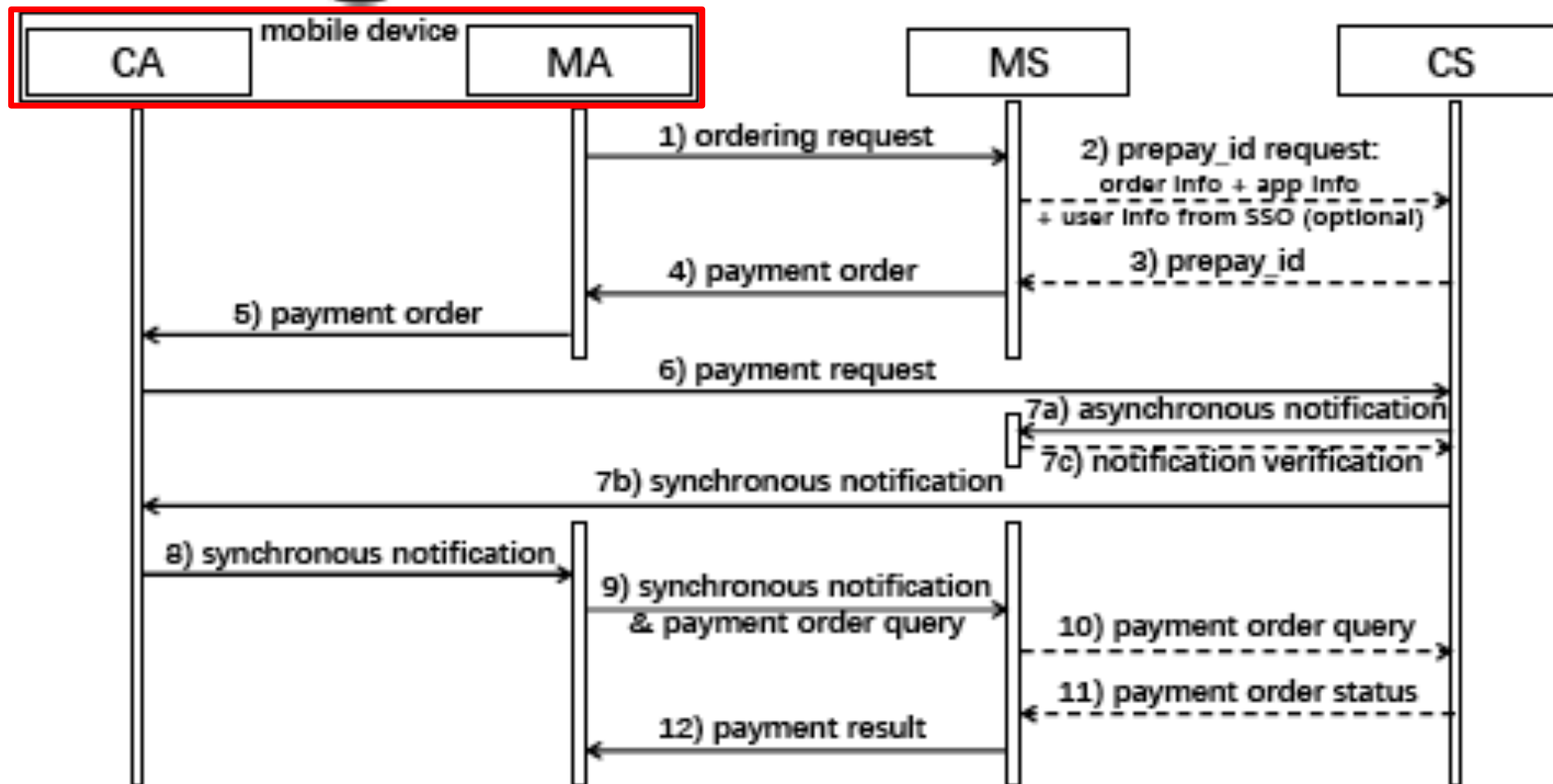


# Operation Flow for Mobile Payment Systems using Time-based One-Time Password



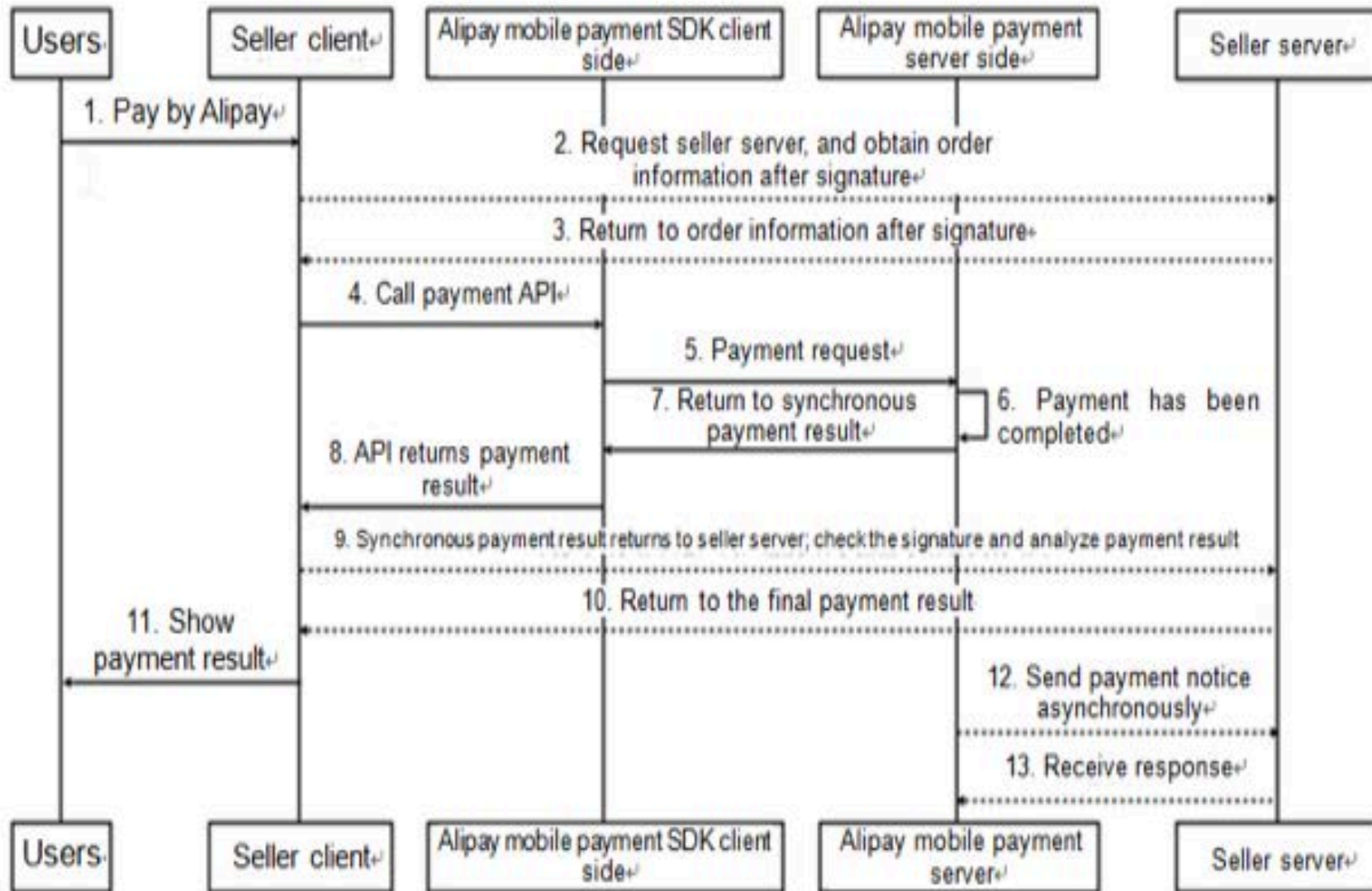
# Detailed Call Flow of Over-The-Top (OTF) Mobile Payment Systems, e.g. Alipay, WeChatPay

CA: Cashier App  MA: Merchant App MS: Merchant Server CS: Cashier Server

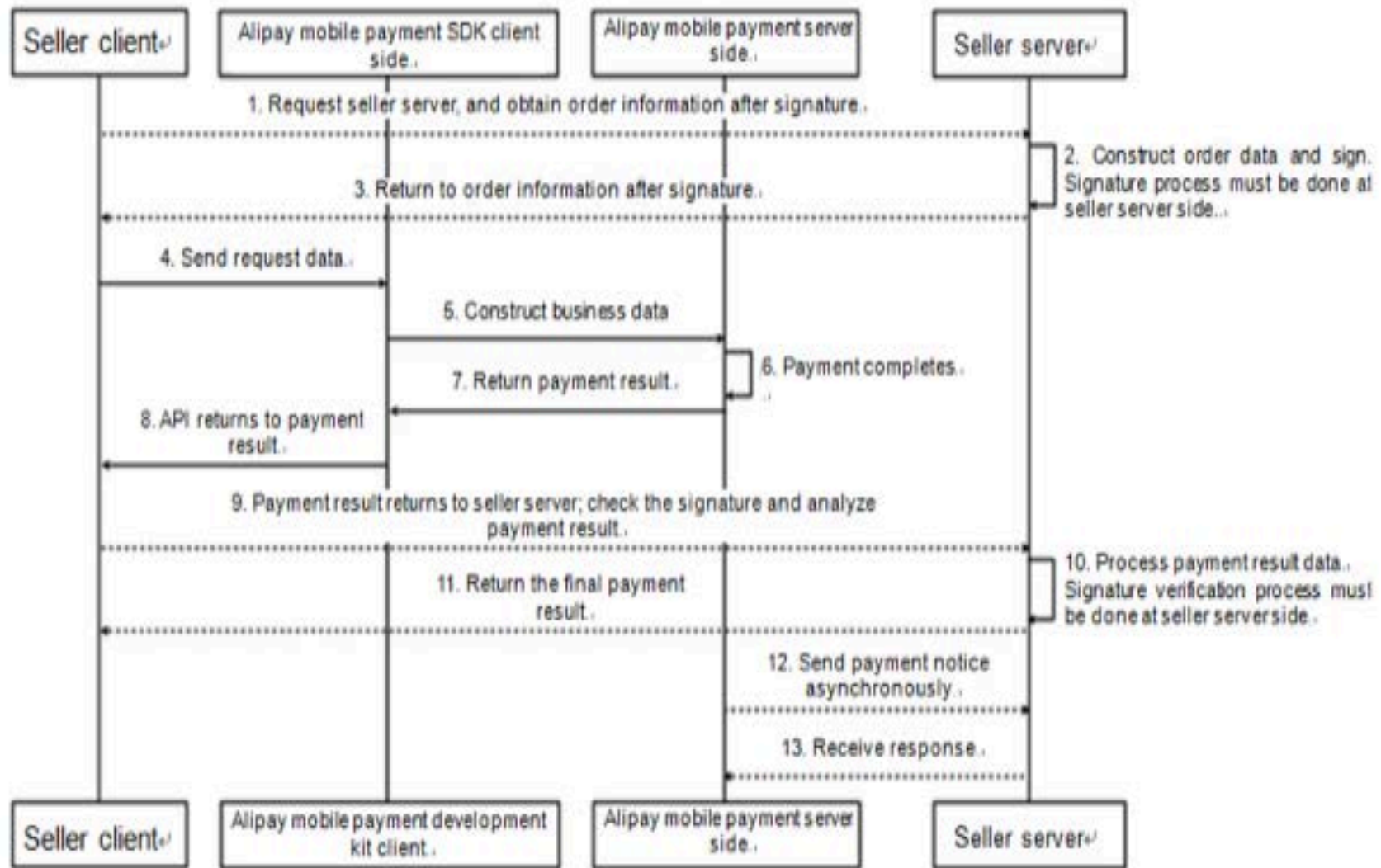


Note: Steps represented by “dashed” arrows may not be implemented by all Cashiers.

# Detailed Call Flow of Over-The-Top (OTF) Mobile Payment Systems of Alipay Global



# Data Interaction of Over-The-Top (OTF) Mobile Payment Systems of Alipay Global



# Too Many

## QR Code Payment Specifications/ “Standards” !

### ■ EMVCo

- ◆ Loosely regulated standard, strict adherence is not required, white label friendly

### ■ mVISA

- ◆ Highly regulated standard, strict adherence, copyrighted standard

### ■ Masterpass QR

- ◆ Highly regulated standard, strict adherence, copyrighted standard

### ■ HKMA Common QR code Spec

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### ■ Alipay, WeChat Pay, UnionPay QR codes

- ◆ Proprietary specifications ; No national standards for interoperability

SOURCE: MITSUBISHI

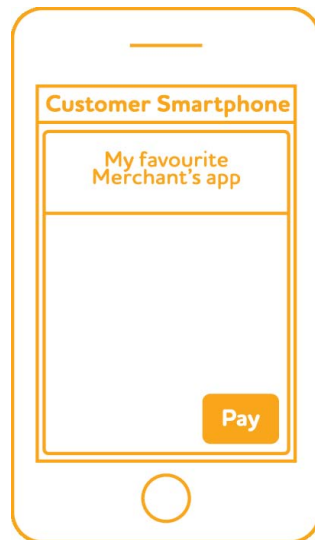
# Problems with Poor QR Code Payment Interoperability



# Mobile Payment Terminals at Point-of-Sale (POS)

# Security Considerations for Mobile Payment Readers at Point-of-Sale (POS)

## Making payments



**A Cardholder uses her phone to:**  
Enter her card details into a web form  
Store her card details (or a token) in a wallet  
Store her card details on a secure element  
(e.g. contactless)

## Accepting payments



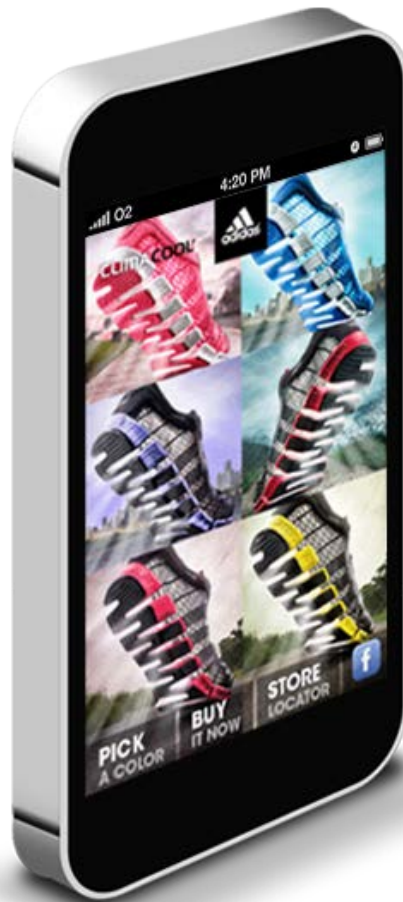
**A Merchant uses his phone to:**  
Accept and process payments from customers  
He will handle many card payments from many customers



# Threat Axes and Vulnerabilities

## *Threat Axes*

- **Over the channel:**
  - SMS / USSD
  - Voice
  - Data: GPRS / Wifi / Bluetooth...
- **Embedded**
- **Mobile Network Provider**
- **The Owner**

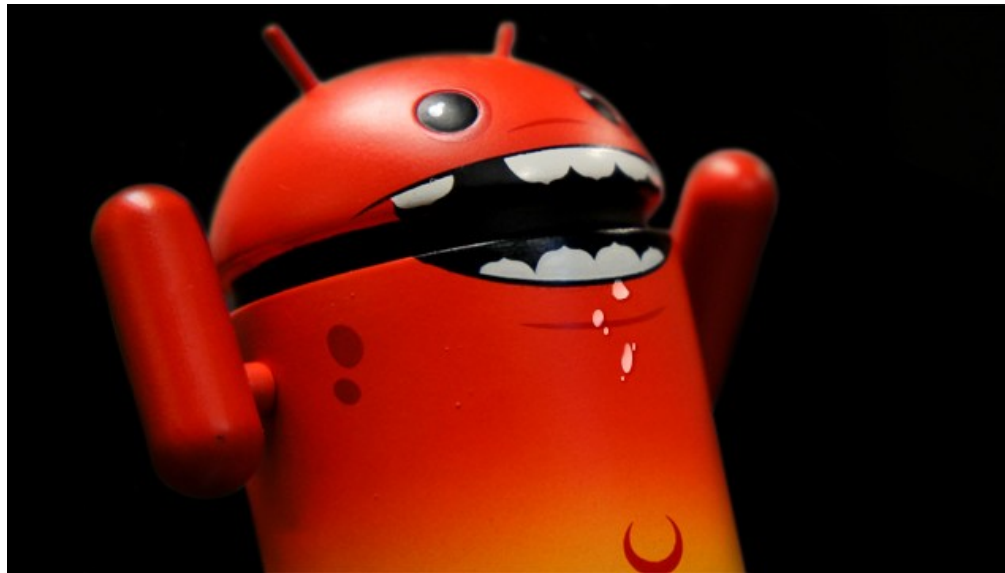


## *Vulnerabilities*

- **Operating System**
- **Hidden processes and applications**
- **User behaviour**
- **User interface**
- **Complexity**
- **User awareness**
- **Mobile registration and ownership**

## Some not so recent news/facts

- 76% of Android malware profit motivated (Q1 2013)
- HTML5 Framework hacks
- Android Security Squad and Bluebox Security – “Master Key” attacks
- SIM hack, Security Research Labs



# What exactly are we trying to protect?

- Basically any data whose theft or modification could cause financial or reputational harm to the Credit card company, its Members and users
- Key assets at risk:
  - Cardholder data (CHD): PAN, Expiry date, CVV, CVV2
  - Sensitive authentication Data: PIN, cryptograms



Q. What can credit card companies/ merchants do to secure the mobile phone of their customers?

A. Not a lot

- Issuers and acquirers need to cater for hundreds of millions of cardholders and millions of merchants
- Mobile Device Management?
- User policies - Enforced AV, restrictive Terms & Conditions?
- Enforce certification of handsets against security standards?

**The reality is that card issuers and acquirers will need to take mobile devices as they come**

**Security strategy must take this into account**

# Innovation with tradition

## Criteria for mobile POS & acceptance



### Honour all cards

Chip & magstripe



### Security

Lowering standards  
would threaten the  
system



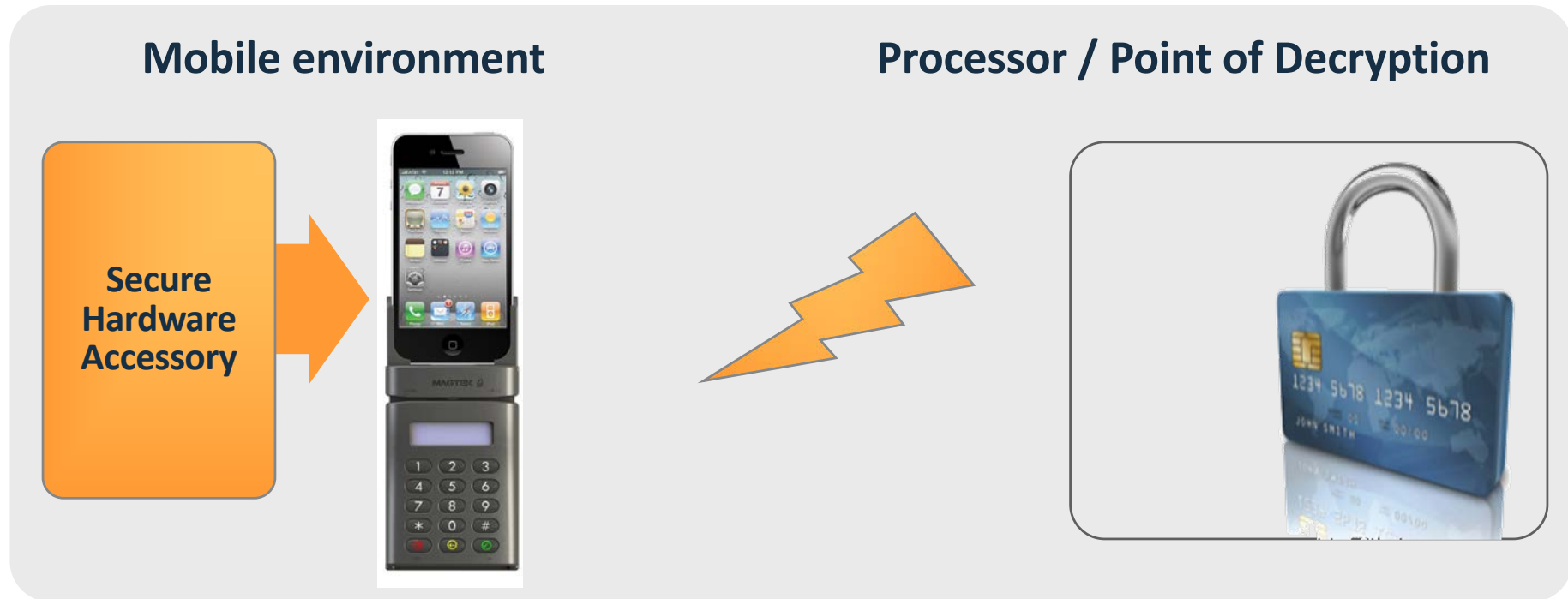
### User experience

Familiar & trustworthy



**Benefits for all  
Trusted Credit Card  
Brands**

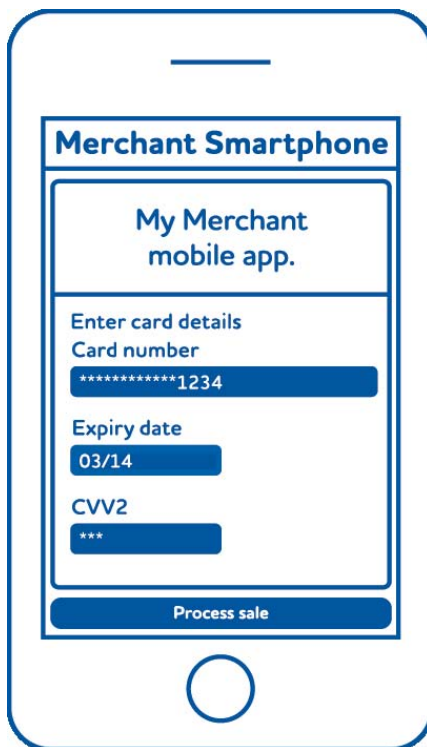
# Visa Europe's position on mobile acceptance devices



Protected in line with Visa's Encryption & Tokenisation Guidelines

# Mobile POS acceptance solutions NOT permitted by Visa Europe (1/4)

“App” with manual key entry of card data on merchant owned mobile device



- Software only solutions with no hardware accessory
- App downloaded on merchant phone
- Card data keyed on merchant phone
  - transactions processed as e-comm or MOTO
- Entry of data on a merchant mobile device cannot be PCI certified at this time
- This also includes PIN entry

# Mobile POS acceptance solutions NOT permitted by Visa Europe (2/4)

Hardware accessory with a magstripe only reader  
(Used with a merchant owned mobile device)



- Solutions with a magstripe only reader:
  - no chip reader
  - no PIN pad
  - transactions sent as a magstripe transaction or as a MOTO or e-comm transactions
- Europe is a region where chip is required so this type of solution is not suitable



# Mobile POS acceptance solutions NOT permitted by Visa Europe (3/4)

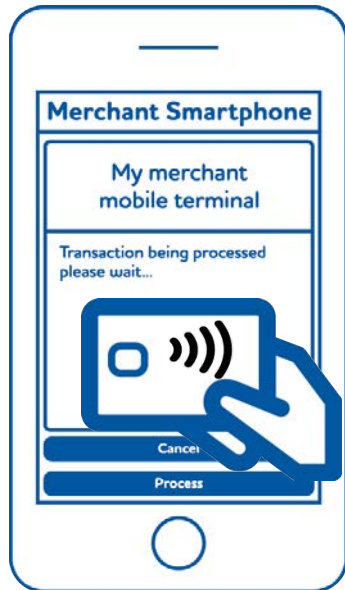
Hardware accessory with a chip reader but no PIN pad  
(used with a merchant owned mobile device)



- Solutions with a chip reader:
  - no PIN pad
  - with or without magstripe
  - transactions sent as chip trs.
- PIN pad required in Europe so this solution is not suitable
- “Honour All Cards” is a must
  - key entry of card data on a merchant phone not permitted: magstripe support required

# Mobile POS acceptance solutions NOT permitted by Visa Europe (4/4)

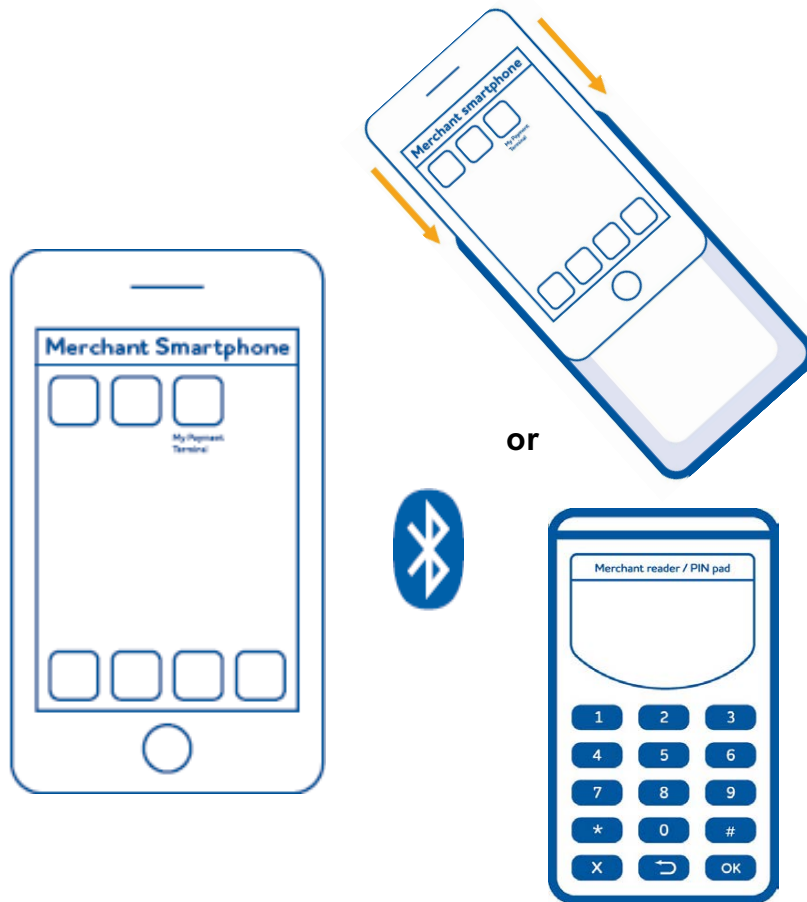
## Contactless only acceptance



- An acceptance device must “Honour All Cards”
- As not all cards support contactless, it is not possible at this time to allow contactless only devices

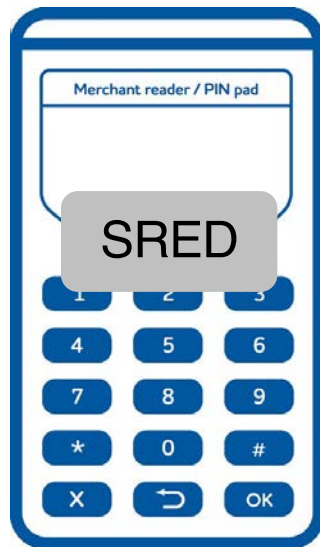
# Two Mobile POS acceptance solutions permitted (1/2)

Hardware accessory with chip, magstripe & PIN pad  
(merchant owned mobile device)



- **Chip & PIN must be supported**
- Magstripe must be supported
- Contactless optional but recommended
- Key entry of data on secure PED allowed when no other option
- Physical (audio jack, mini USB etc.) or Bluetooth connection to mobile device
- Security is ensured by PCI SRED (Secure Read Exchange Data) and point-to-point encryption)

# Anatomy of mobile card reader security



## **Security standards**

PCI PIN Transaction Security (PCI PTS)

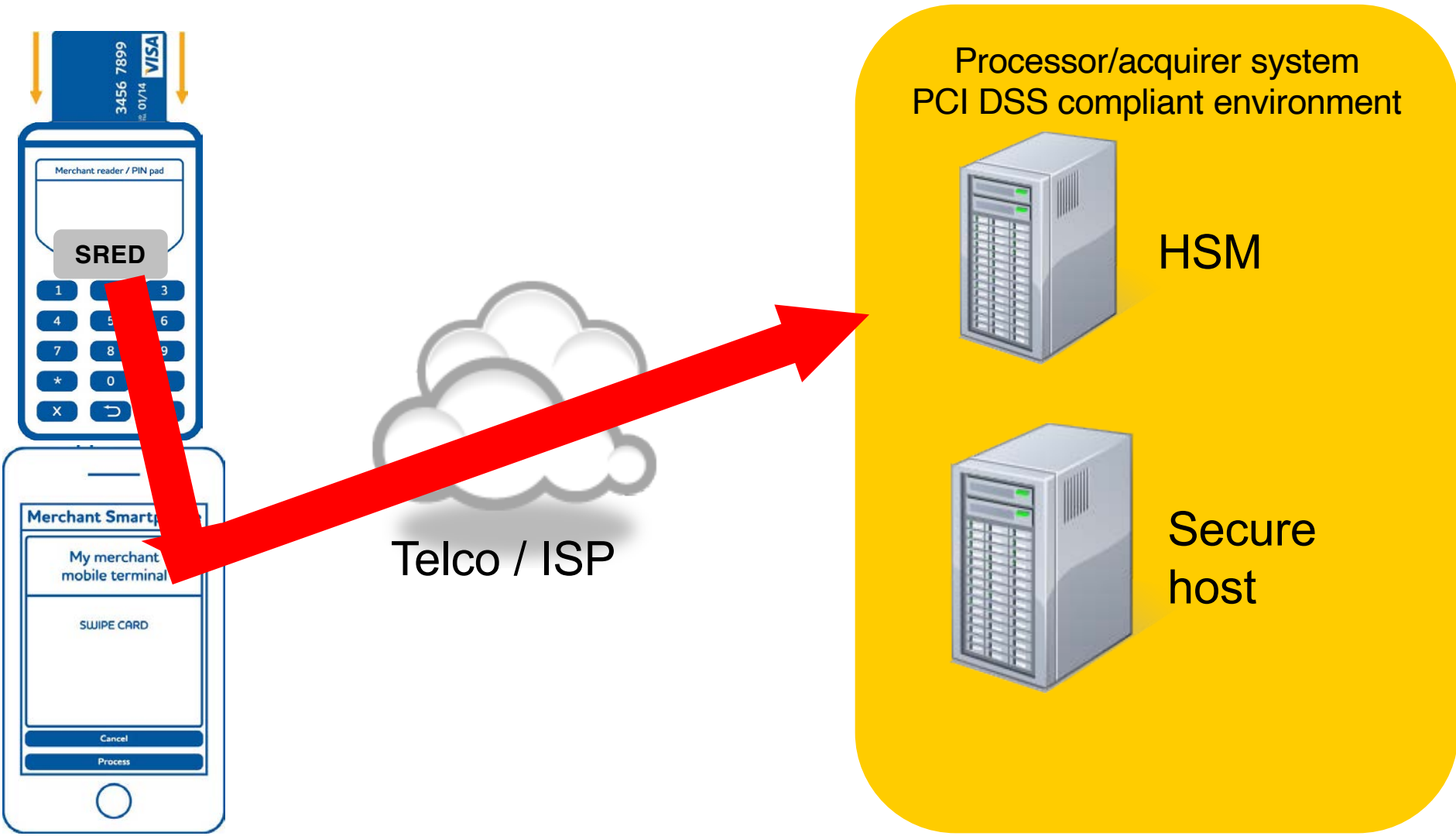
Secure PIN entry

Device hardened against physical & logical hacking

Encryption – SRED\* module

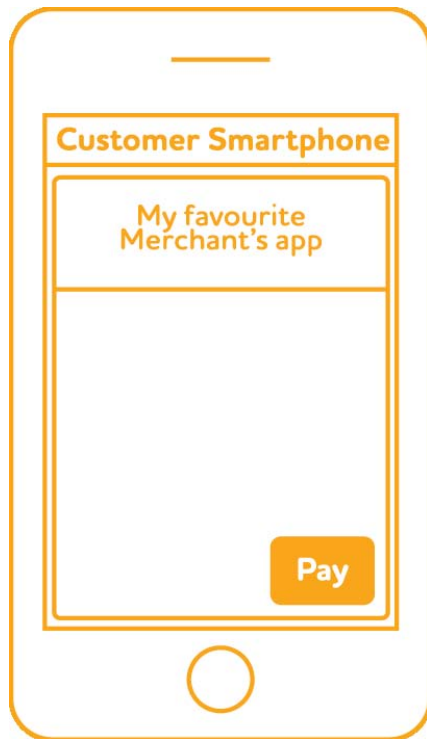
\* SRED = Secure Read and Encryption of Data. SRED is a hardware module for secure key storage & encryption functions

# Encryption on the reader removes the mobile device from the key areas of risk



# Mobile POS acceptance solutions permitted by Visa Europe (2/2)

Software based solution/ M-commerce app  
(cardholder mobile device)



- Card details never entered on merchant mobile device
  - Secure if back end, registration process and permission to use protected
  - Refer to **Visa Security Best Practices for Mobile Payment Acceptance Solutions, Version 2.0** – published in Sept. 2012  
<http://www.visaeurope.com/ais>

# Major Focus / Characteristics

- Consistent and familiar experience for cardholders and merchants
- Increase likelihood that cardholders and merchants will use Mobile POS acceptance
- Maintain and reinforce the trust in the brand
- Ensure that any exciting new method of payment starts secure
- Bringing new players to market
- Reduced costs

# Mobile POS solutions in EU (circa 2014)

Mobile devices allowing low cost and easy access payments

Balancing security and integrity with ease of deployment

7 live implementations

200k+ merchants by 2014

10 European markets



Working with industry providers

payleven

intuit

WorldPay

Elavon

iZettle



Quite Different Regulatory and Business  
Landscape in the US side



SWIPE



Accept credit cards from Android or iPhone

RECEIPT

**SIGHTGLASS** 12/01/09 at 9:13:58 AM  
2 cappuccinos, caramels **\$11.50**

Best Western Americana  
Natomia St  
Howard St  
Howard St  
Rausch St  
Summer St  
8th St  
Moss St  
7th St  
Folsom St  
Langton  
Sherman St  
Columbia St

**Sightglass Coffee**  
270 7th Street  
San Francisco, CA 94110  
@Sightglass

This is your **5th** purchase here.

1c was donated to [charity:water](#).

This should appear on your statement as:

Description	Amount
SQUARE * SIGHTGLASS	\$11.50

x *Jackson Walker*  
6746

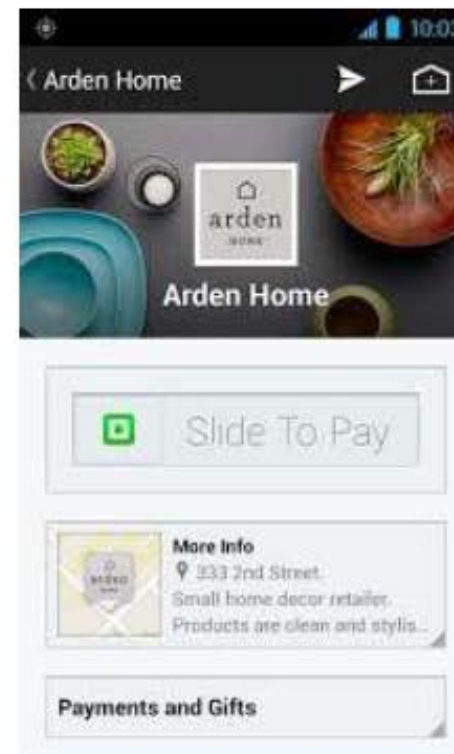
SIGNATURE





# Square mobile products Square

## Mobile app/Square wallet





# Square mobile wallet Square

## Strengths:

- Innovators of square credit card reader;
- Flat 2.75% per swipe which is less than PayPal;
- Cheap POS station for the merchants;
- Deposits money within 1-2 business days;
- There is an option to add a tip to the cashier;
- Free mobile card reader to the registered user and immediate digital receipt of the payment.

## Weaknesses:

- Need to carry extra device in pocket in case of credit card reader;
- Difficult to explore businesses on the App and there is no classification of the business type;
- Minimal security and no pin protection;
- Needed physical presence of the user, and his username at the payment system.

# SWOT Analysis

## Opportunities:

- It processed \$15 billion in 2013 and expected to increase from this mark;
- This app is being used at 7000 Starbucks stores to pay the bill;
- Can extend it to independent business owners like taxi drivers.

## Threats:

- PayPal came with a new card reader which is a threat;
- There are other competitors like Isis, and lemon wallet etc.



# PayPal mobile wallet

## Strengths:

Core technology backed up by eBay;  
All the user has to do link bank account, debit or credit card with PayPal account and shop from there with a single tap;  
Support from almost all credit/debit card companies (Visa, etc.) and Cloud based;  
International transactions with higher limit;  
PayPal has been around for a long time and has much bigger user base.

## Weaknesses:

Debit and credit card transfers are not free;  
Transfers are deposited in the recipient's PayPal account, which have to then be withdrawn;  
Charges more for the merchants per transaction when compared to competitors.

## SWOT Analysis

## Opportunities:

PayPal is already the leader in the industry and it is well known for international transactions, it can extend its market with that image;  
Over 10 million downloads form the market which are potential leads;  
143 million active buyers looked for PayPal when shopping online.

## Threats:

So many competitors are entering into the market, once upon a time PayPal is the well known commerce site;  
PayPal is losing the market share to Square;

# Examples of Mobile POS acceptance Providers/ Vendors in US

Provider	Region Available	Magnetic Stripe/EMV	Card Reader Cost	Transaction Fee Options
Intuit Go Payments	North America	Magnetic stripe	Free	Per transaction fee, or fixed monthly fee and lower per transaction fee
iZettle	Western Europe Latin America	EMV	Free for chip and signature Fee for chip and PIN	Per transaction fee
mPowa	Global	EMV	Fee for chip and PIN	Per transaction fee
PayAnywhere	North America	Magnetic stripe	Free	Per transaction fee
payleven	Western Europe Latin America	EMV	Fee for chip and PIN	Per transaction fee
PayPal Here	North America	Magnetic stripe	Free	Per transaction fee
Square	North America	Magnetic stripe	Free	Per transaction fee or fixed monthly fee
SumUp	Western Europe	EMV	Free	Per transaction fee

Provider	Tablet POS Hardware Fee	Bring Own Device	Processing Provided	SaaS Fee	Value-Added Services Offered	3rd Party Service Support	Peripherals Supported
GoPago	Free	No	Yes	Monthly fee	Loyalty/rewards Mobile ordering Sales analytics Customized menus Table availability	No	Card reader Stand Barcode scanner Cash drawer Printer Scale
Groupon Breadcrumb	Yes	No	Yes	Monthly fee	Offers Inventory tracking Sales analytics Time tracking Table availability Customized menus	Yes	Card reader Stand Cash drawer Printer
NCR Silver	Yes	Yes	No	Monthly fee	Sales analytics Customized menus	No	Card reader Stand Barcode scanner Cash drawer Printer
PayPal	Yes	Yes	Yes	None	Inventory tracking Sales analytics Time tracking	No	Card reader Stand Barcode scanner Cash drawer Printer
Revel Systems	Yes	Yes	No	Monthly fee	Inventory tracking Sales analytics Time tracking Customized menus	Yes	Card reader Stand Barcode scanner Cash drawer Printer Scales
ShopKeep POS	Yes	Yes	No	Monthly fee	Sales analytics Time tracking Customized menus	Yes	Card reader Stand Barcode scanner Cash drawer Printer
Square Register	Yes	Yes	Yes	None	Inventory tracking Sales analytics Time tracking	No	Card reader Stand Barcode scanner Cash drawer Receipt printer Kitchen printer
Square Stand	Yes						

## Examples of Tablet-based Mobile POS Solution Providers in the US

# The Mobile Payment Business



# Different forms of Mobile Payment Services

- Mobile Proximity Payments
  - ◆ This refers generally to contactless payments at the Point-of-Sale terminals using a Smartphone
- Remote Purchase using Mobile Device
  - ◆ This covers payments that take place online, e.g. Internet Shopping
- Person to Person (P2P) Mobile Payment
  - ◆ Use mobile device to complete fund transfer transactions between individuals, e.g. based on email address (Paypal, Venmo), Phone number (Payme), Online Social Network/ Mobile App Account (Venmo)
- Mobile Banking
  - ◆ Transfer money between bank accounts, pay bills, control spending limits etc.

# Mobile Payments 1.0 (in Europe 2000-2005)

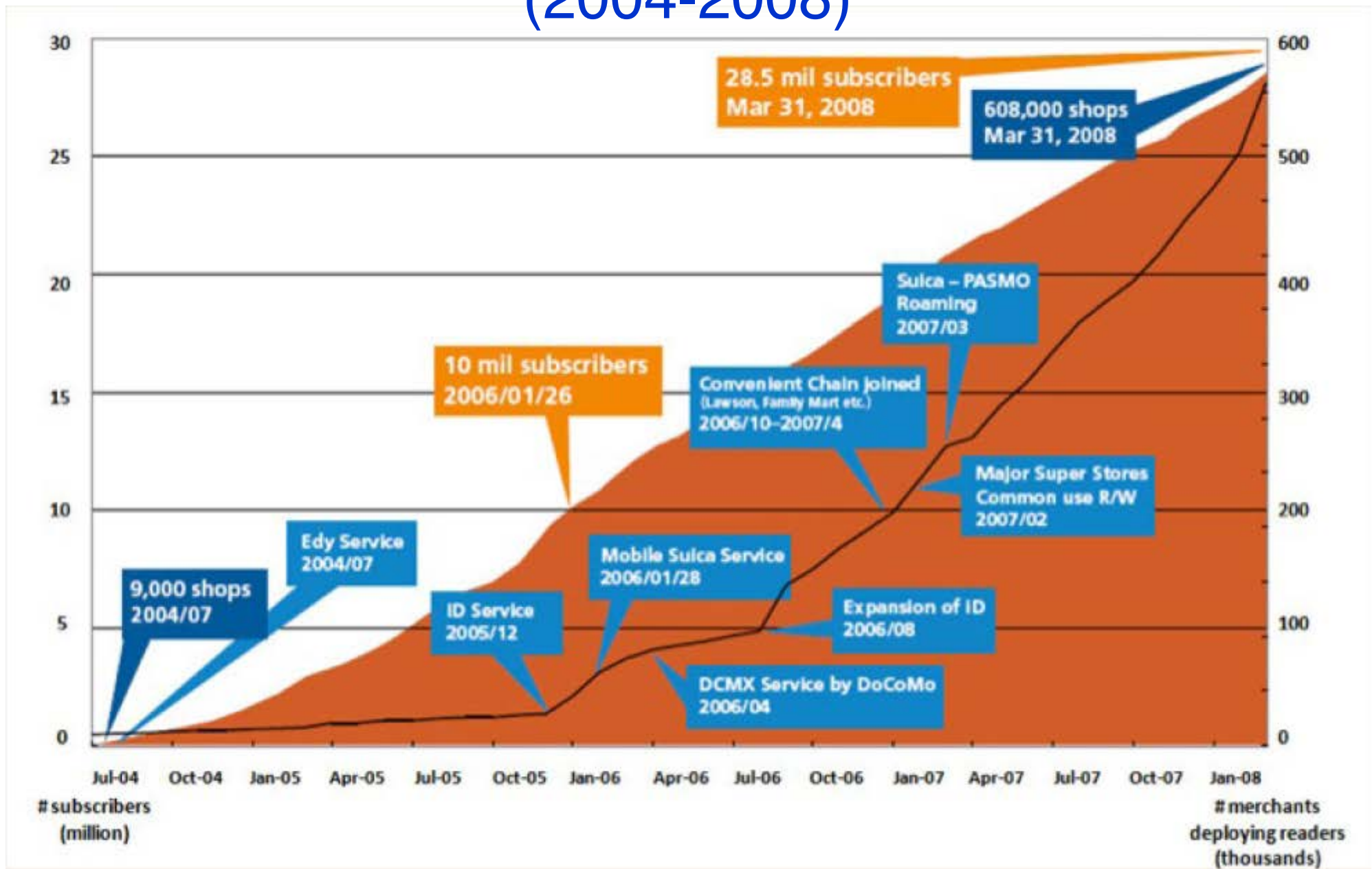
- Many early European mobile payment initiatives have failed, mainly due to poor usability and lack of availability.
- Mobile payments 1.0 in Europe was dominated by Premium SMS
  - ◆ 20%-40% revenue share for telecom operators
  - ◆ In 2006, 1 Billion Euros purchased via Premium SMS
  - ◆ Used by 60% of young consumers
- Better consumer acceptance in niche sectors such as m-parking
  - ◆ In Croatia, > 50% of all parking fees were paid by mobile phone.
- Europe was far behind Japan and South Korea in mobile payment adoption.

# Contactless Mobile Payments 1.0 (2008)

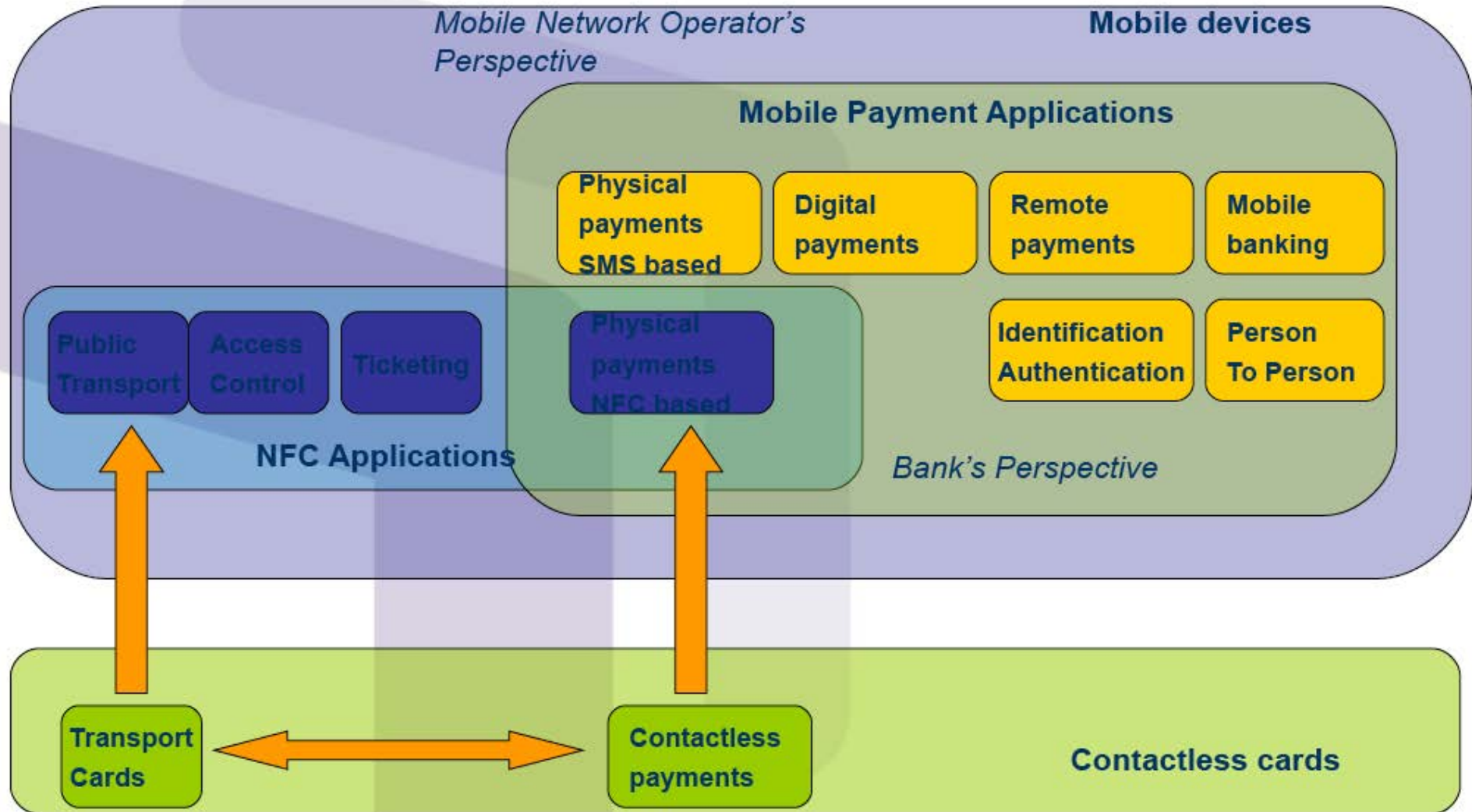
Metric/Statistic	Japan	South Korea	United States
<i>Mobile phone penetration</i>	87% (2008) <sup>30</sup>	93% (2008)	88% (2008) <sup>31</sup>
<i>Number of mobile wallet-capable phones deployed</i>	78 million	12 million	Only in trials
<i>Number of citizens using mobile wallets</i>	17 million phones; 68 million smart cards	3.6 million phones; 18 million T-money smart cards	Only in trials
<i>Number of merchants deploying RF-capable POS readers/ total number POS readers deployed</i>	608,000 merchants deploying/total number POS readers deployed much larger <sup>32</sup>	+500,000 total POS readers deployed <sup>33</sup>	140,000 merchants deploying/ +500,000 POS readers deployed <sup>34</sup>

Source: Contactless Mobile Payment ITIF Report 2009

# Growth of Mobile Payments Adoption in Japan (2004-2008)



# Mobile Payment 2.0 (2006-2010)



# Early NFC (SE-based) Trials/ deployments in the World (2009)

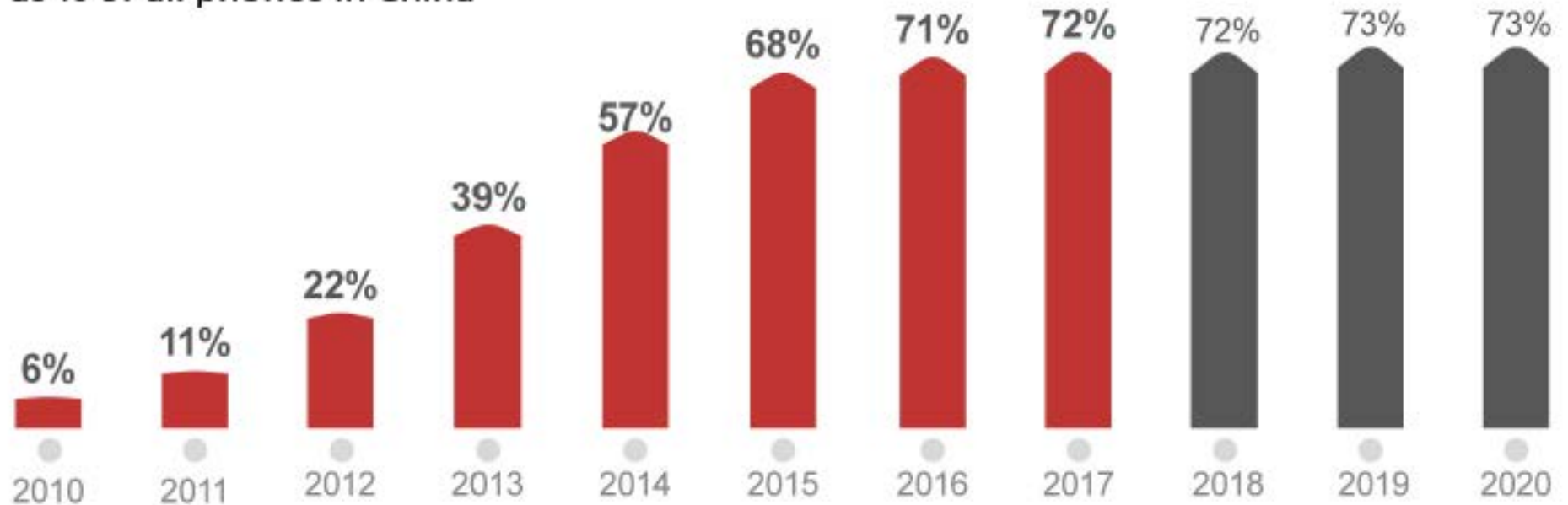


- Japan with Sony FeliCa, NTT DoCoMo
  - ◆ Reported to have 10 million mobile credit card customers
- StoLPan (Store Logistics and Payment with NFC)
  - ◆ Pan-Euro consortium supported by EU's Commission's Information Society Technologies program
- Visa launched NFC trial in Brazil
- Citi launched NFC trial in India
- Telefonica launched O2 Money, ready to deploy NFC
- Nokia Money
  - ◆ 41 NFC-related trials and launched in Asia Pacific region by 2009.

The Rise of Mobile Payments  
in China  
(2009 onwards)

# China's shift to Smartphones

Smartphones  
as % of all phones in China



Source: GSMA



# Number of chinese online shoppers (in millions)



# Driving forces behind Mobile Payments in China

**Mobile commerce** → Chinese consumers much more comfortable shopping on their mobile phones vs U.S.

**Lack of legacy infrastructure** → Less resistance from other legacy payments methods like credit cards

**Marketplaces** → Open approach to mobile shopping fortified by Alibaba marketplaces, and WeChat go-to messaging platform, which support Alipay and Tenpay

**Social Media Platforms** → Leverage their customer base to enter the e-commerce business

**Chinese travelers abroad** → Chinese outbound tourists projected to exceed 200M in 5 years from the current 110M

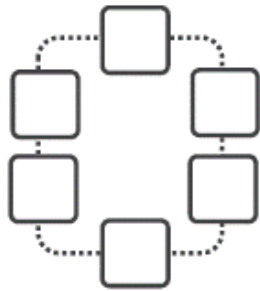
**WeChat Pay/Alipay/UnionPay intensify expansion**

## Super apps vs. traditional apps



### Standalone app

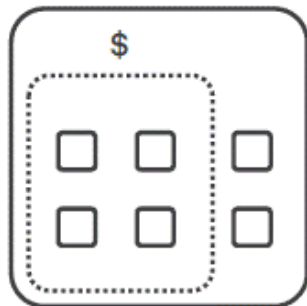
A single app with a single main function



### App suite

A collection of apps with related functions and ability to integrate with one another, often owned by the same company

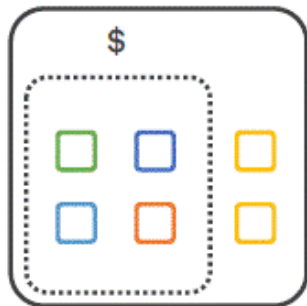
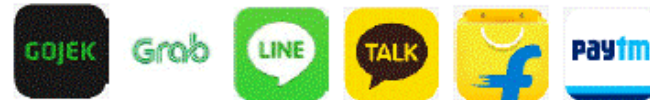
Examples: G Suite, Microsoft 365, Adobe Creative Suite



### Super app

A single app with multiple functions, often facilitated by a payment system by the same company

Examples: Go-Jek, Grab, LINE, KakaoTalk, Flipkart, Paytm



### Super app + third-party mini programs

A single app allowing third-party companies to develop lightweight "mini programs" that can run within the app, often facilitated by a payment system by the company of the app

Examples: WeChatAlipay, Baidu, Meituan, Tmall



# The Rise of Super Apps in China

Data compiled July 2019.

Credit: Julber Osio; Shirley Gil

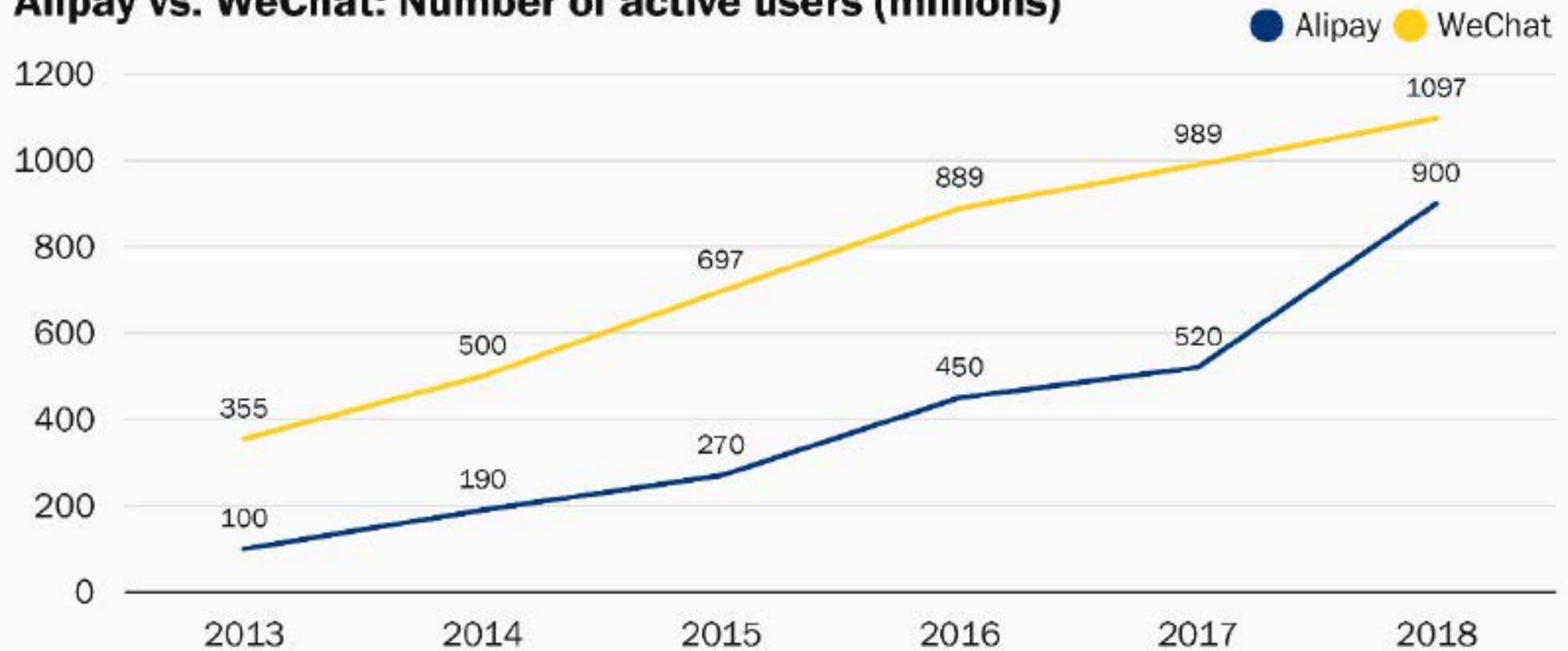
Source: Industry data

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# Growth of user base of Alipay vs. WeChat

**Alipay vs. WeChat: Number of active users (millions)**



Source: Statista, China.org.cn, XinhuaNet, Technisia

**B** | Economic Studies  
at BROOKINGS

Chinese Mobile Payments Surge 61% YoY in 2018: PBOC Report

# Proximity Mobile Payment Users and Penetration in China

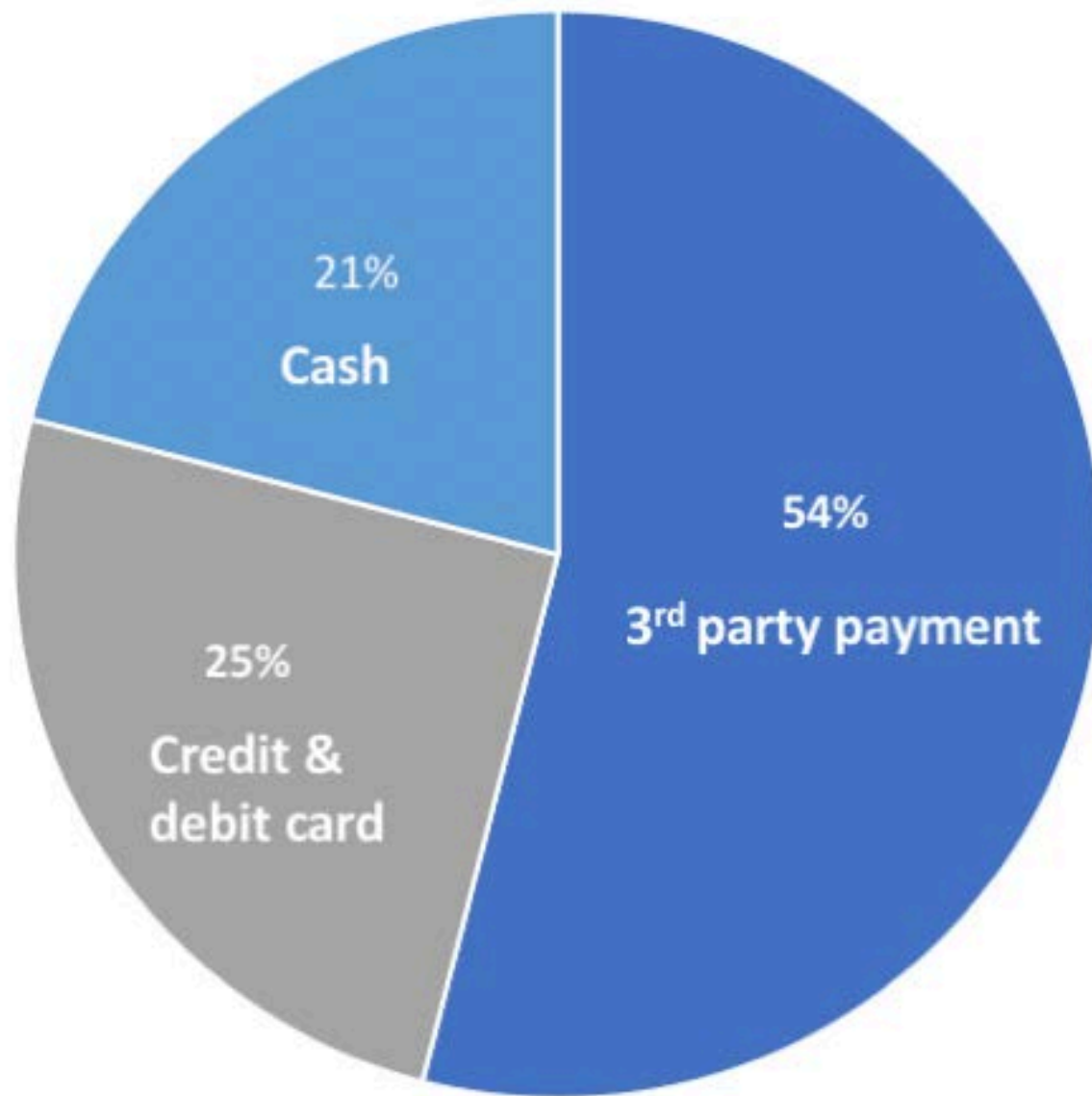
Chinese vs. US Adoption Comparison:  
 In 2017, 76% Chinese vs. 25% US smartphone users had made a mobile POS purchase ;  
 61.8% such transactions globally are Chinese



Note: ages 14+; mobile phone users who have made at least one proximity mobile payment transaction in the past 6 months; includes point-of-sale transactions made by using mobile devices as a payment method; excludes transactions made via tablet; exclude Hong Kong.

Source: eMarketer, Nov 2017

# How do Chinese pay?

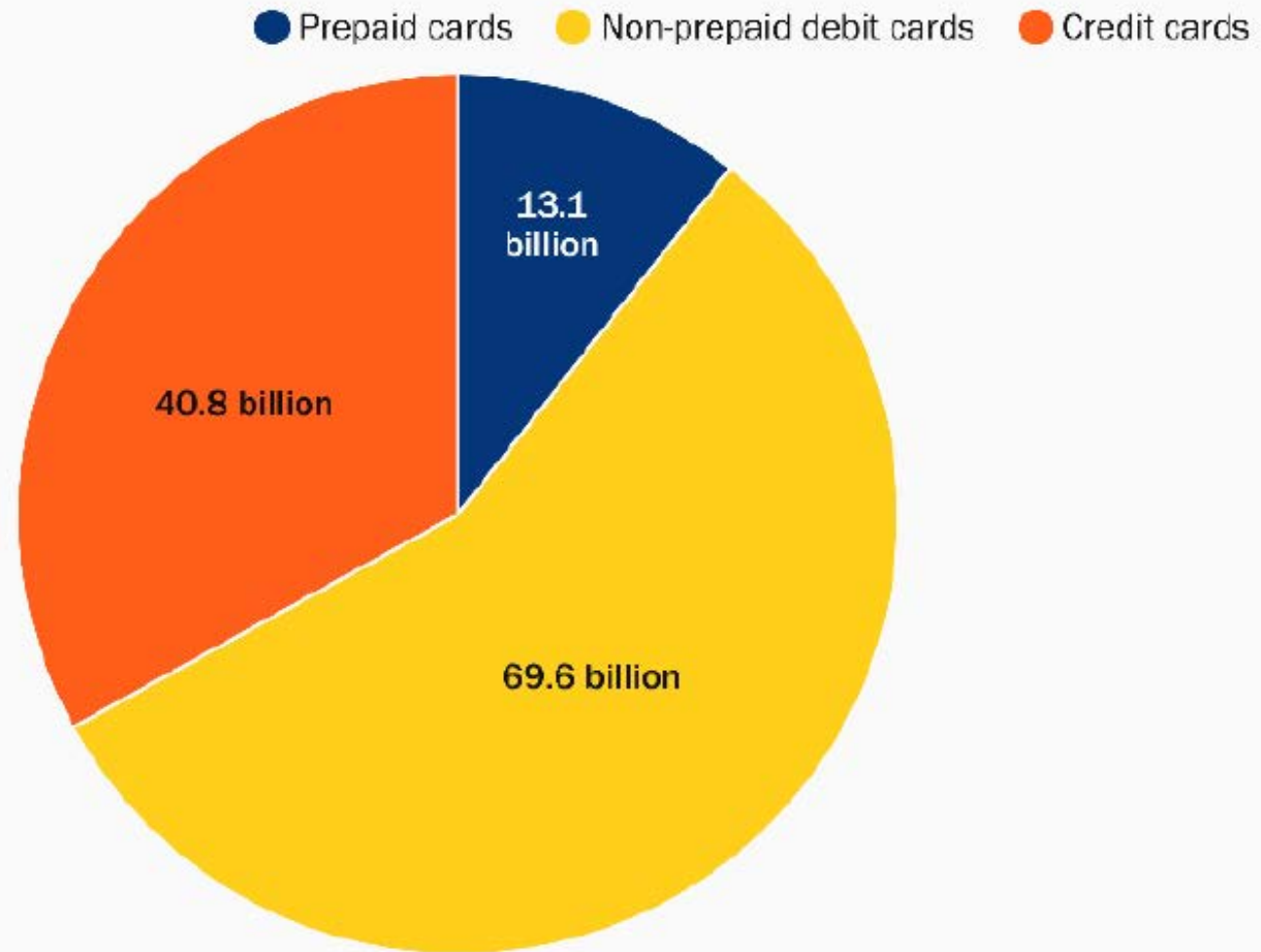


Source: Ipsos 2018 Q4 Third-Party Mobile Payment User Report, sample size 2,000

WALKTHECHAT

# Market Share of different types of Payment Cards in US (2017)

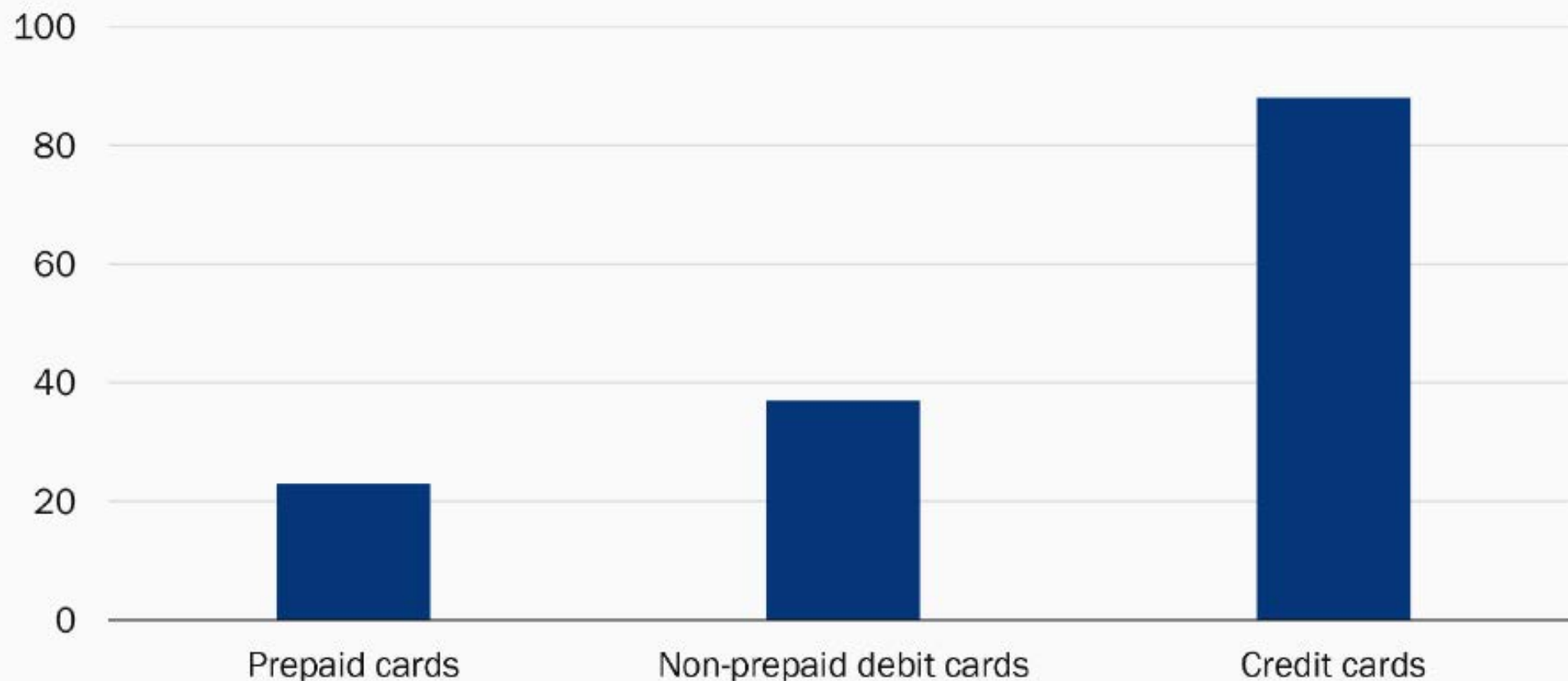
**Total number of transactions, 2017**



**Source:** Board of Governors of the Federal Reserve System

# Average Transaction Amount of different types of Payment Cards in US (2017)

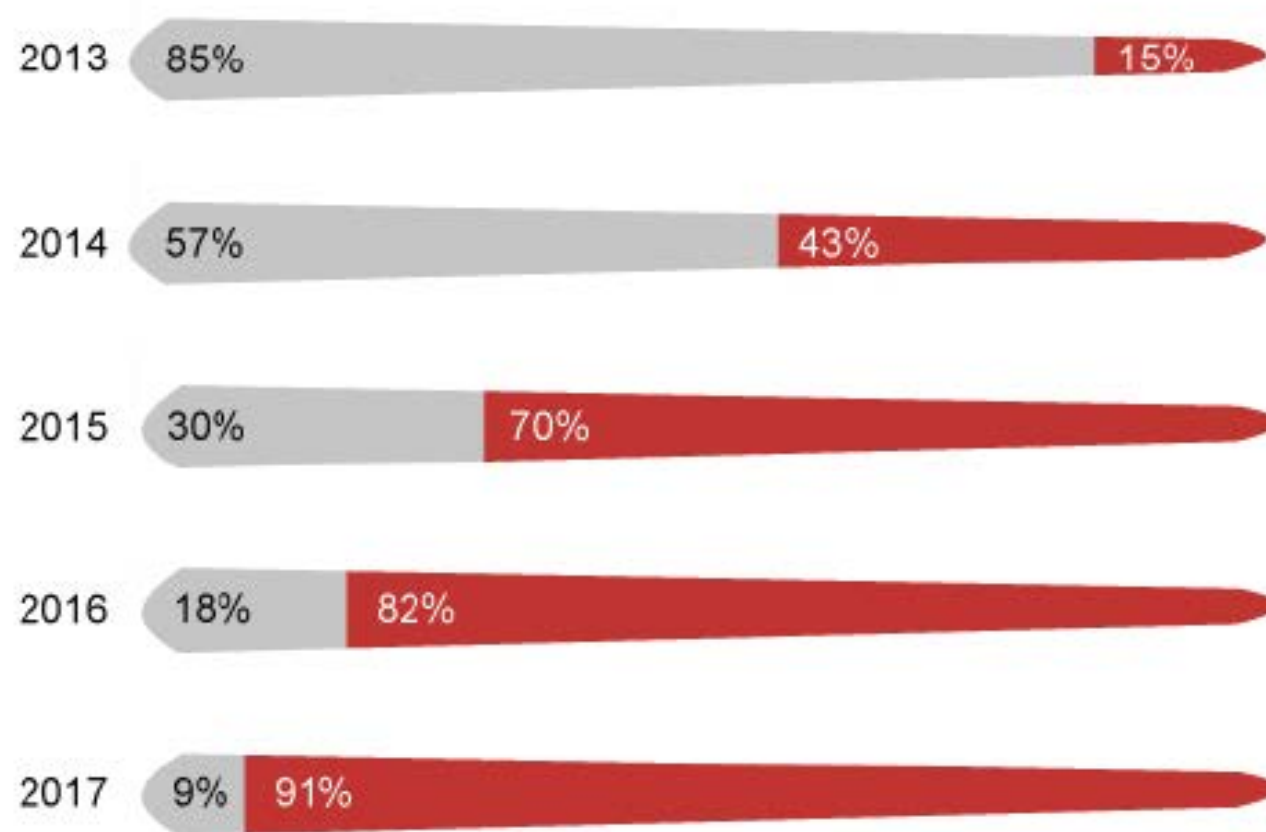
**Average value of card transaction (\$)**



**Source:** Board of Governors of the Federal Reserve System



# Mobile Shopping Share in China



# Mobile Payment > 50% across all retail sectors

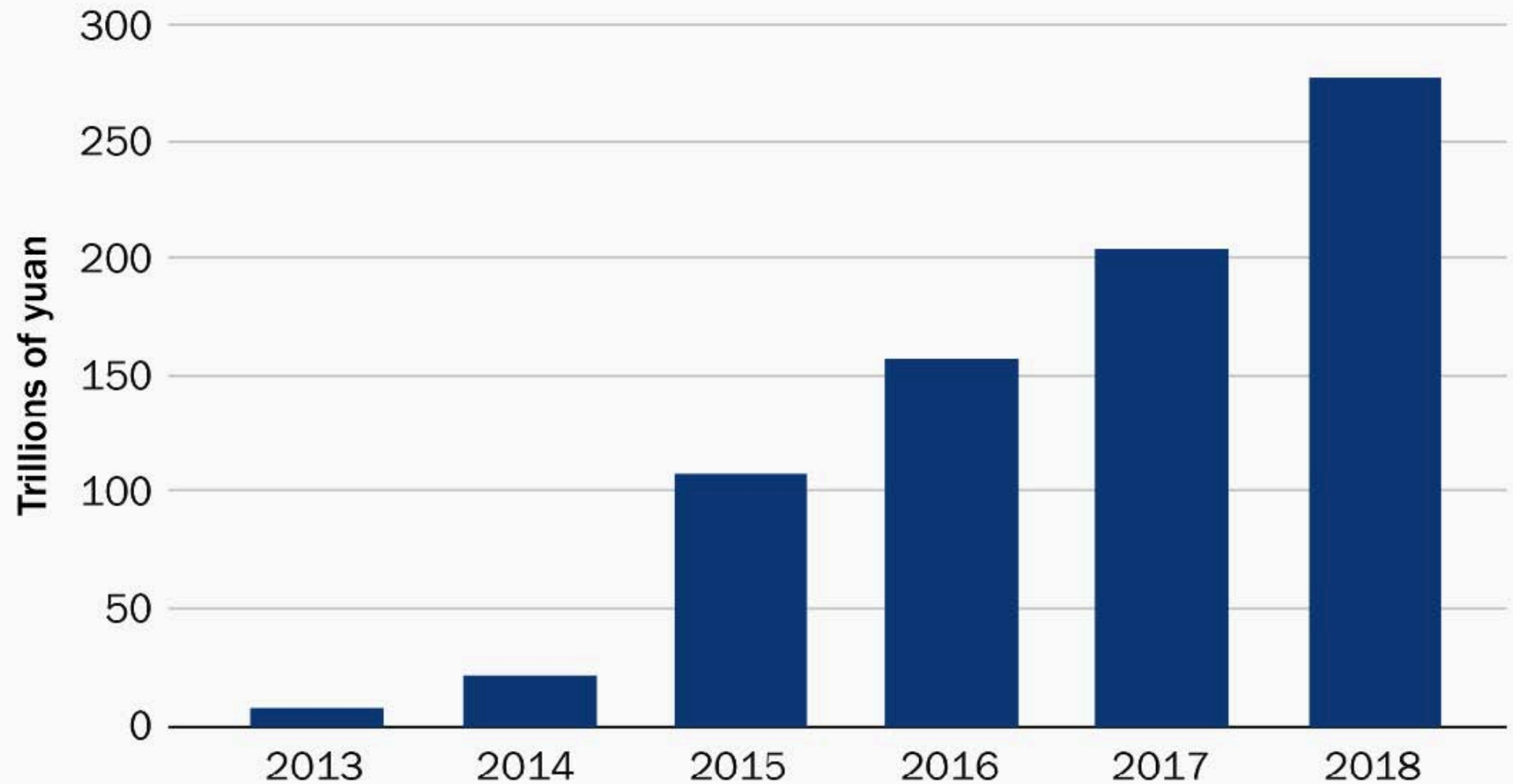


● Mobile Payment  
● Cash  
● Credit card  
 % by payment method

Sources: Tencent, Ipsos – RDCY Summer 2017



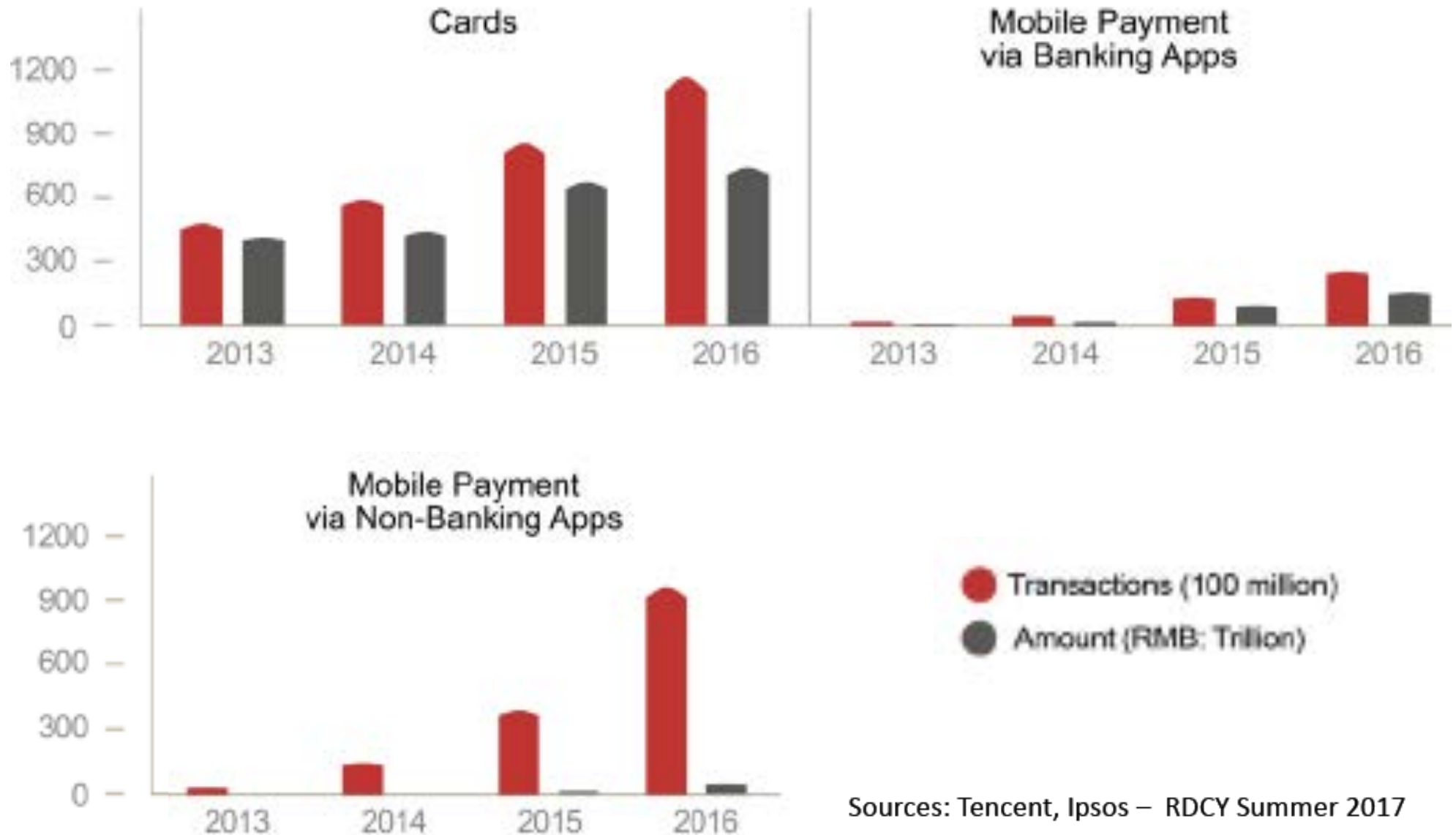
## Mobile payment transaction volume



**Source:** People's Bank of China, Caixin Data, CEIC

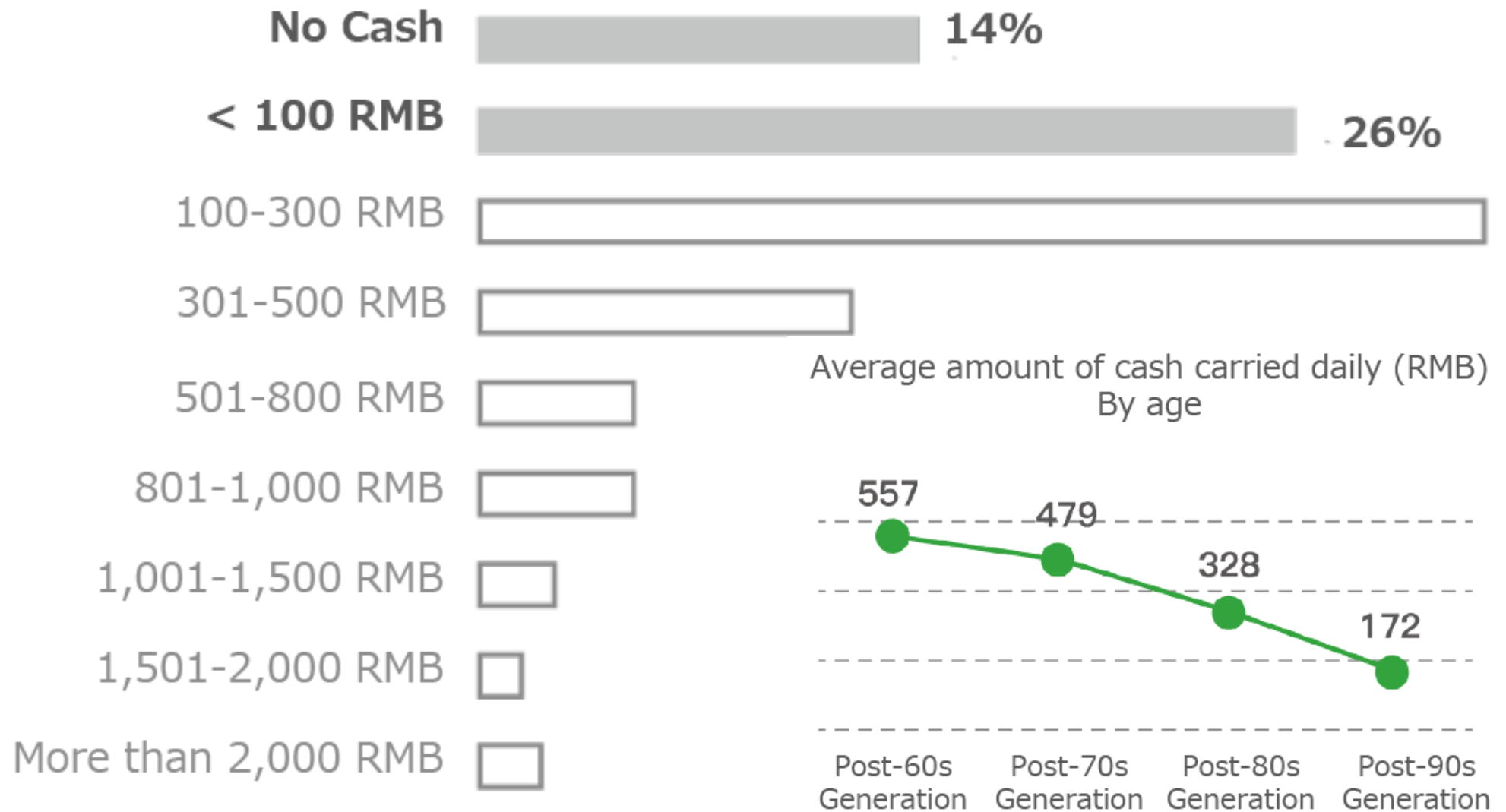
**B** | Economic Studies  
at BROOKINGS

# Mobile Payment via Non-Bank Services/ Apps



Sources: Tencent, Ipsos – RDCY Summer 2017

# 40% of Chinese Regularly carry < 100 RMB cash



# 52% of Chinese use Cash for < 20% of their monthly consumption

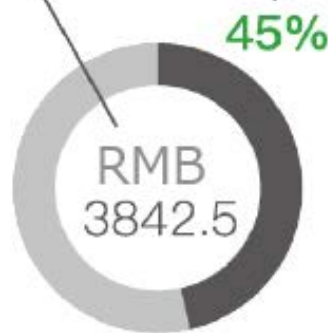


*How much cash do you spend per month?*

52% respondents said less than 20% of their monthly spend was conducted via cash.

Total spending

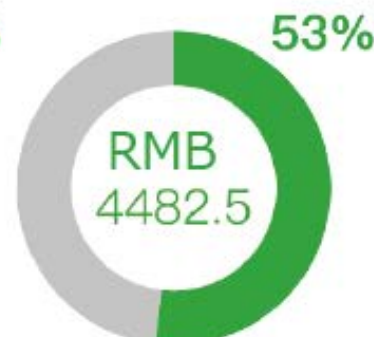
Proportion of people who spend  $\leq$  20% money in cash each month



Post-60s Generation



Post-70s Generation



Post-80s Generation

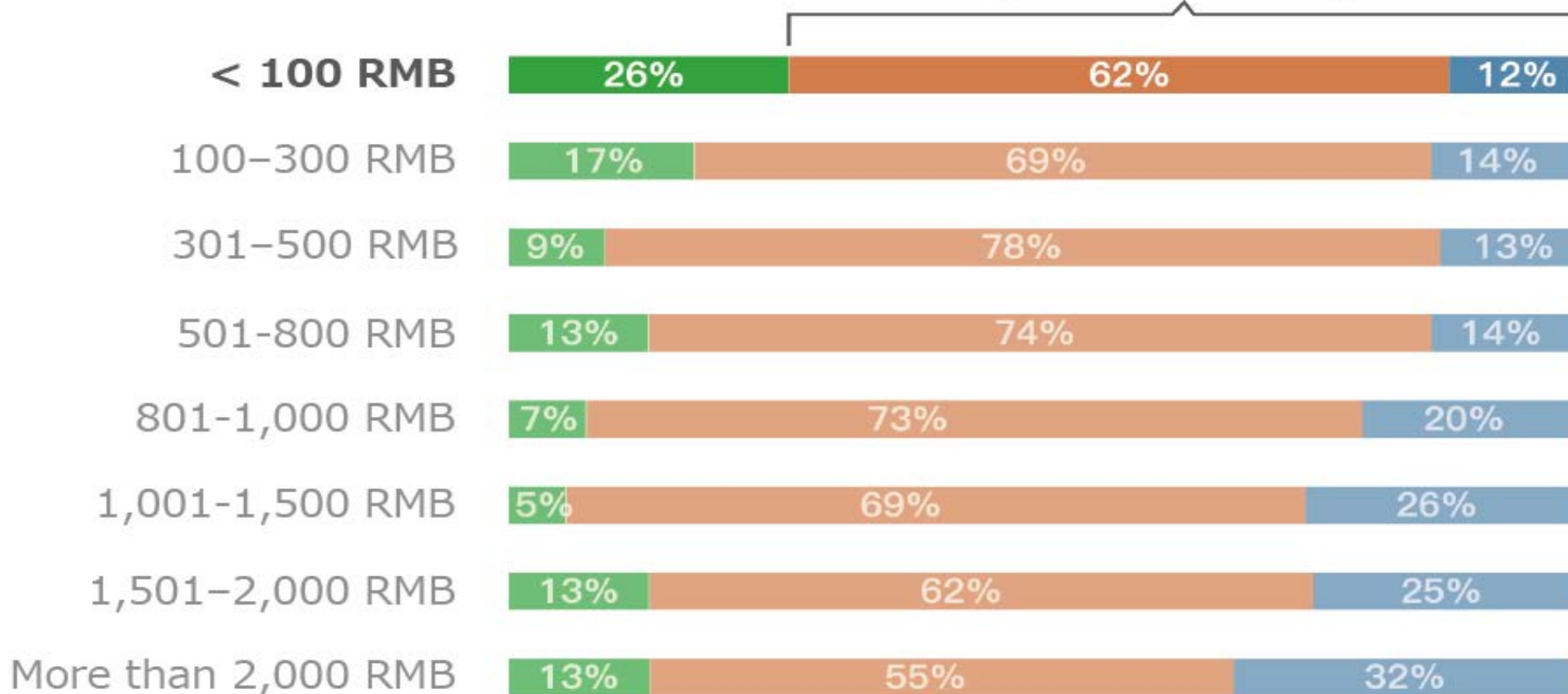


Post-90s Generation

# How Long can one survive with < 100 RMB in Cash ?

Less than a week    1-4 weeks    More than 1 month

*74% of people stated that they can live for more than a single month with only 100 RMB.*



# How does one feel if he/she does not carry any cash ?

*"I'd be concerned all-day that there'd be a situation requiring cash."*



**12%**

Concerned



**4%**

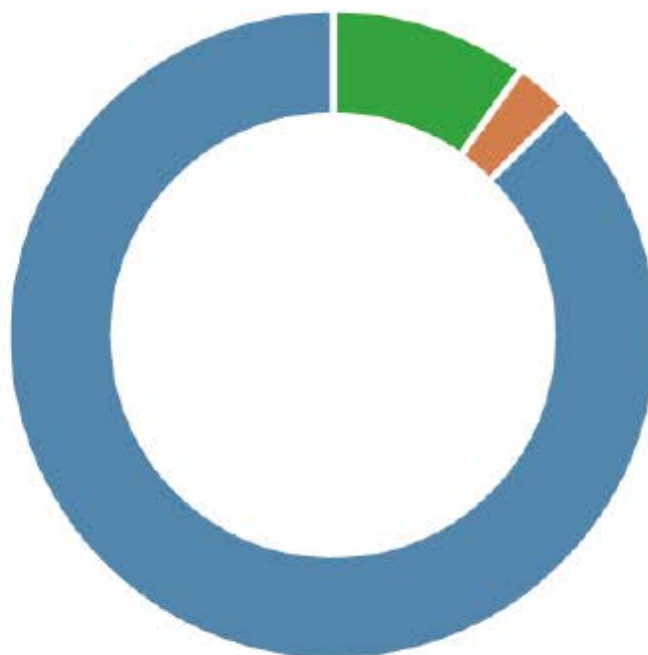
Refusal

*"It's not acceptable. I must go home or to an ATM."*

  
**84%**

Calm

*"Whatever, I can use mobile payments."*





# How does one feel if he/she does not carry any cash ?

*"I'd be concerned all-day that there'd be a situation requiring cash."*



**12%**

Concerned



**4%**

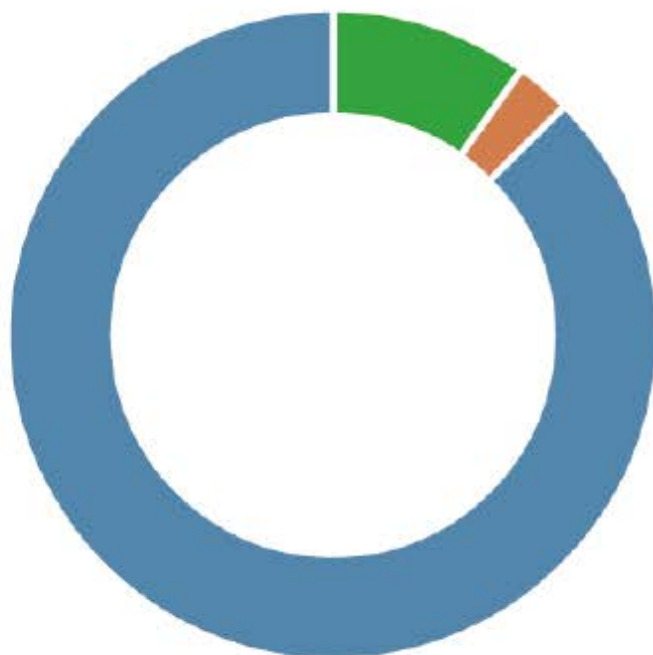
Refusal

*"It's not acceptable. I must go home or to an ATM."*

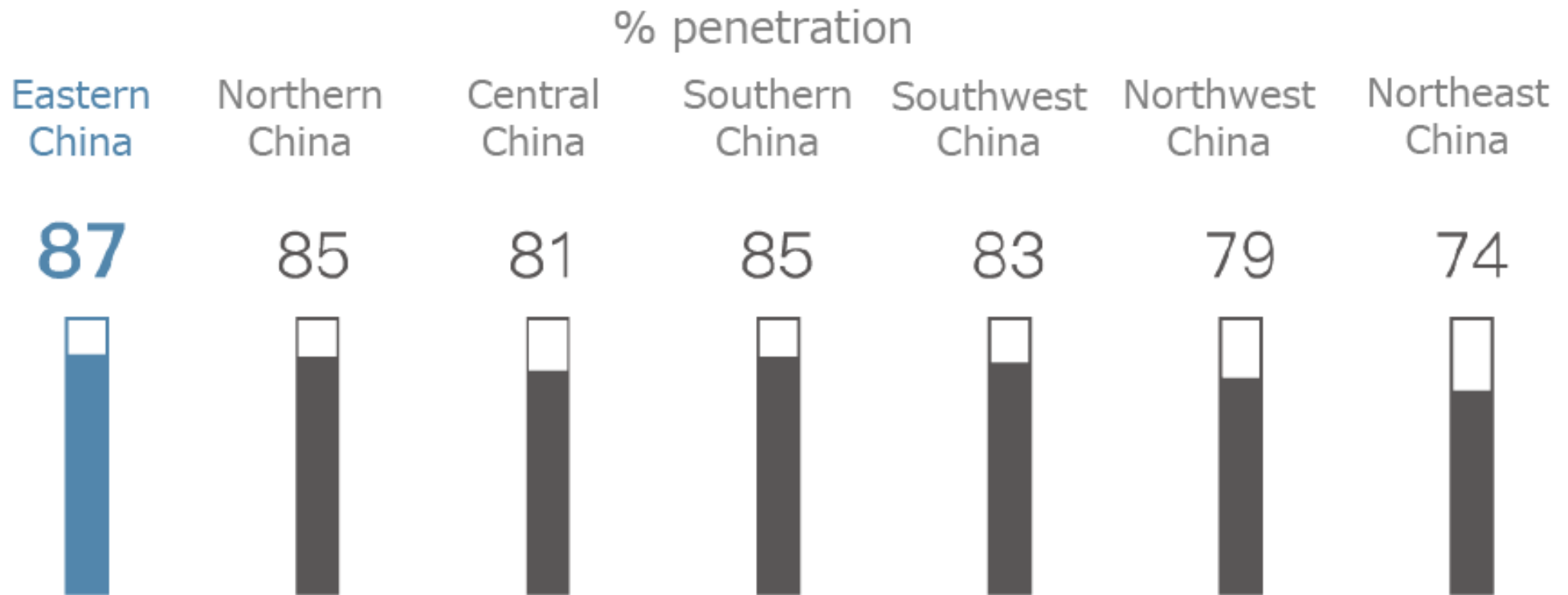
  
**84%**

Calm

*"Whatever, I can use mobile payments."*

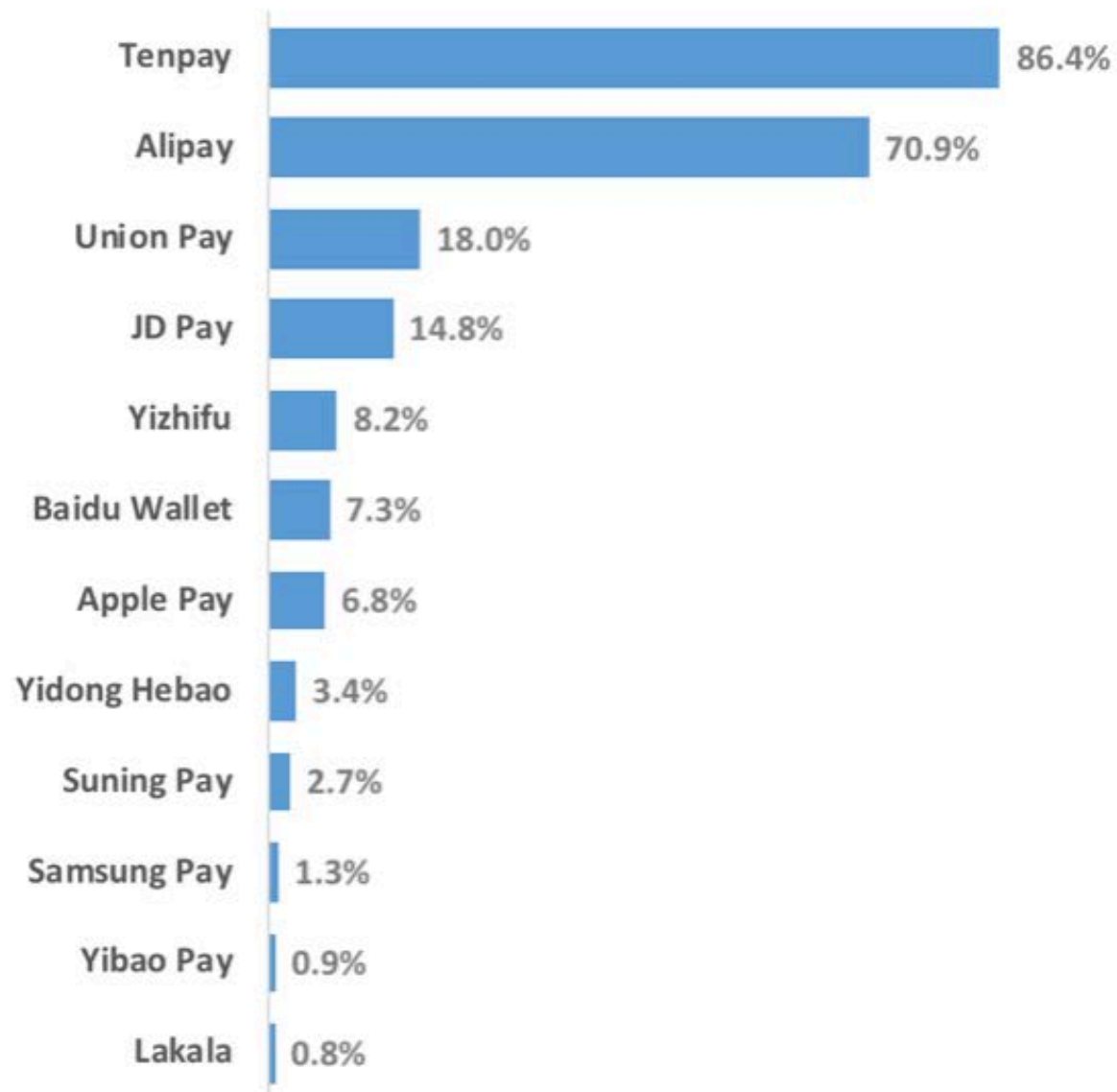


# Users' Reception of the Cashless Lifestyle by Region



People in the the Eastern China region are the most accepting of a cashless lifestyle. 87% of interviewees are fine with a totally cashless life.

# Payment Method User Penetration % 2018 Q4



Source: Ipsos 2018 Q4 Third-Party Mobile Payment User Report; sample population 13,148

WALKTHECHAT

Company	Country	Value (bn USD)
Alibaba	China	484.5
Tencent	China	474.4
Visa	United States	347.5
Mastercard	United States	248.2
Ping An	China	223.9
Paypal	United States	126.5
Baidu	China	59.3
Lending Club	United States	1.4
Moneysupermarket	United Kingdom	N/A

# Top 3 Online/Mobile Payment Providers in China

- Alipay (circa Jan 2019)

- ◆ 520 million registered users, 450 million active.



- WeChat Pay (from Tencent) (circa Jan 2019)

- ◆ 800 million+ active users






- China UnionPay (CUP or just UnionPay)

- ◆ 16 million merchants in Mainland China
- ◆ UnionPay app works in 48 countries and regions
- ◆ UnionPay QR code payment available in 32 countries and regions outside Mainland China
- ◆ UnionPay app users can also do tap-and-go payments at over 2.8 million POS terminals in 37 countries and regions.
- ◆ Since UnionPay is part of EMVco, UnionPay issued credit cards can be added to Apple/Samsung/Google Pay, as well as using Contactless payment at 19 millions POS terminals worldwide.



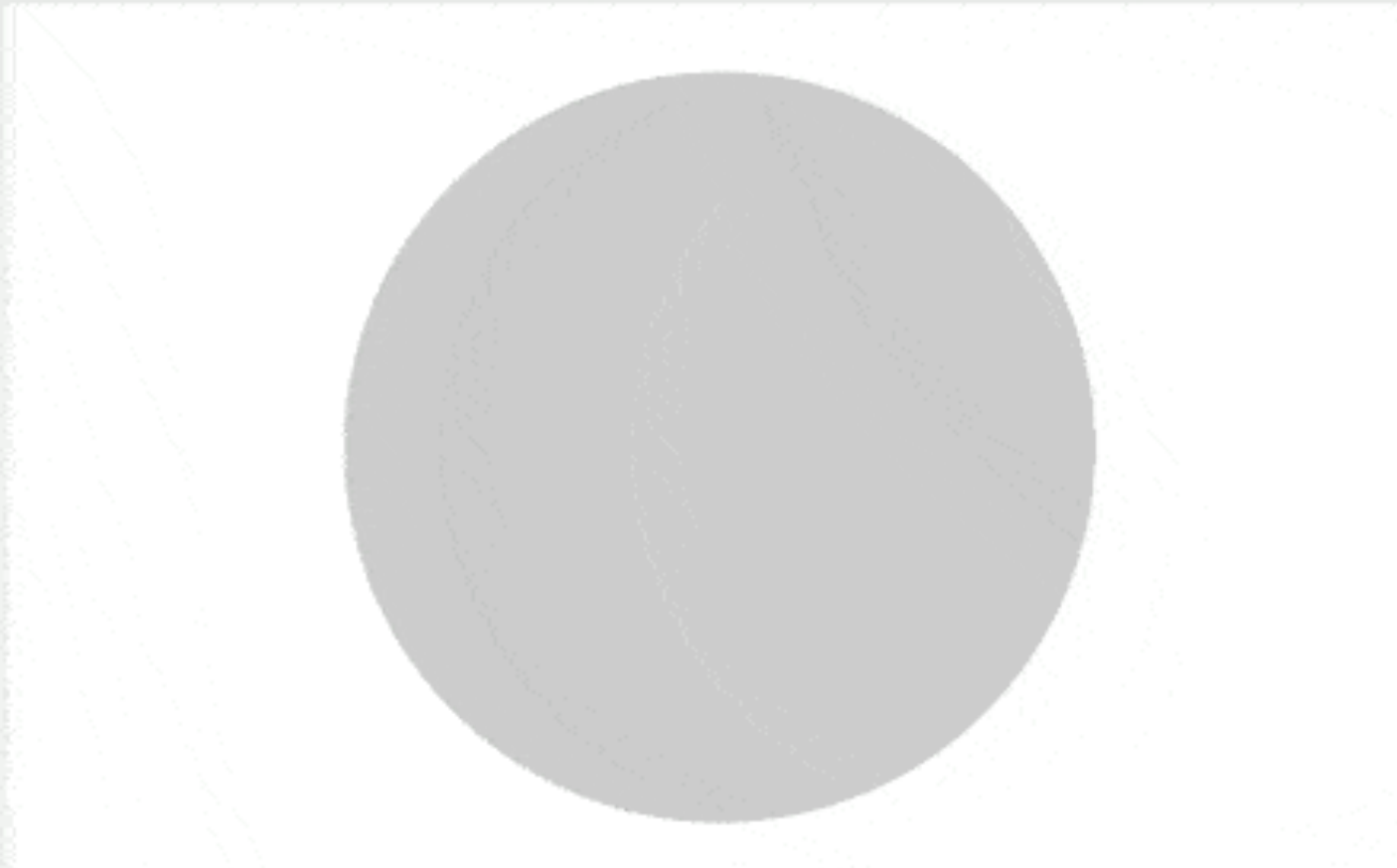
# Services of Mobile Payment Providers

SERVICES			
<b>Devices supported</b>	All smartphones, tablets and computers	Most smartphones	All smartphones, tablets and computers
<b>Financial services offered</b>	<ul style="list-style-type: none"> <li>• Money transfer</li> <li>• Bill sharing</li> <li>• Bill payments</li> <li>• E-commerce payments</li> <li>• Mobile balance top-up</li> <li>• Bank account balance check</li> <li>• Hotel booking</li> <li>• Purchase tickets</li> </ul>	<ul style="list-style-type: none"> <li>• Money transfer</li> <li>• Bill payments</li> <li>• E-commerce payments</li> <li>• Access to wealth management funds</li> <li>• Mobile balance top-up</li> <li>• Taxi ordering</li> <li>• Hotel booking</li> <li>• Purchase tickets</li> </ul>	<ul style="list-style-type: none"> <li>• Withdrawing cash from ATM</li> <li>• Credit card consumption on POS</li> <li>• Bill payments</li> <li>• Card repayments</li> <li>• E-commerce payments</li> <li>• Purchase tickets</li> <li>• Hotel booking</li> <li>• Money transfer</li> <li>• Reissuing new cards</li> <li>• Tax refund in 36 countries</li> <li>• Issue receipts</li> <li>• Promotions or coupons from merchants</li> <li>• Pay Tax balance</li> </ul>
<b>Currencies supported</b>	18	Major ones	Almost all
<b>Transaction charges</b>	Only on withdrawals at a rate of 0.1% per transaction over RMB¥20,000 (US\$153)	Only on withdrawals at a rate of 0.1% per transaction over RMB¥1000 (US\$153)	Most of the consumers' transactions are free, CUP charge fees for ordinary merchants at a rate of 0.7% fixed for bank, 0.1% for CUP

# Summary Comparison (circa 2019)

	WeChat Pay	Alipay	China UnionPay (QuickPass app)
<b>Number of users</b>	800 million	1000 million (320 million daily active users)	160 million (18 million DAU)
<b>Share of China's mobile payment market</b>	38.9%	53.8%	n/a
<b>Market penetration rate</b>	84.3%	62.6%	11.6%
<b>Number of supported currencies</b>	13	27	Almost all
<b>Fees</b>	<p><b>Users:</b> 0.1% for withdrawals over RMBY 1,000</p> <p><b>Merchants:</b> 0.6%</p>	<p><b>Users:</b> 0.1% for withdrawals over RMBY 20,000</p> <p><b>Merchants:</b> 0.55%</p>	<p><b>Users:</b> bank fees</p> <p><b>Merchants:</b> 0.8%</p>
<b>Supported devices</b>	Devices that support WeChat	All phones, tablets, and PCs	All phones, tablets, and PCs

## Mobile payment usage, China (% of all surveyed adult internet users)



Q: Which of the following digital payment applications (digital wallet) do you use?

Base: 1,000

Credit: Julber Osio, Chris Allen Villanueva

Source: Kagan China online adult consumer survey, July 2019

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Source: S&P Global Market Intelligence:

<https://www.spglobal.com/marketintelligence/en/news-insights/research/who-uses->



## Social media sites and e-commerce platforms used by mobile payment users, by service, China

(% of each mobile payments provider)

Social media sites	WeChat Pay	Alipay	China UnionPay	E-commerce platforms	WeChat Pay	Alipay	China UnionPay
WeChat	96	95	92	Tmall	87	86	88
Tencent QQ	73	72	77	Taobao	83	83	84
Sina Weibo	46	45	54	Jingdong Mall	72	72	78
Meituan	42	42	53	Pinduoduo	42	41	47
Zhihu	27	27	36	Suning	27	26	37
Baidu Tieba	26	27	35	VIP	24	23	32
Ioudou Youku	22	22	30	1688	24	23	32
Meitu	15	14	19	Xiaohongshu	20	20	27
Douban	12	12	18	Yihaodian	14	14	20
Momo	9	9	14	Kaola	14	14	19
Others	2	2	3	yMatou	5	6	7
None of the above	0	0	1	Mia	4	4	6
				Others	2	1	2
				None of the above	1	0	0

Questions: Which of the following social media sites do you use? Which of the following e-commerce platforms do you use?

Base: All surveyed - 1,000, WeChat Pay - 901, Alipay - 944, China UnionPay - 452, Others - 23

Source: Kagan China online adult consumer survey, July 2019

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Source: S&P Global Market Intelligence

## Smartphone activities over the past 3 months per mobile payments provider, China

(% of each mobile payments provider)

Additional smartphone activities over the past 3 months	WeChat Pay	Alipay	China UnionPay
Using your smartphone app for mobile payment at a physical retail store	66	65	68
Purchased physical goods using a mobile app or website	65	64	68
Accessed your personal bank accounts from your bank's mobile app or website	64	63	72
Purchased online music	25	25	33
Downloaded a paid mobile app	23	23	28
Remotely monitored a smart appliance or home security system	21	21	29
Purchased e-books	20	19	26
Purchased online digital games	19	18	22
None of the above	5	6	4

Questions: Which of the following activities have you performed on your Smartphone over the past 30 days? Which activities have you done over the past 3 months using your smartphone?

Base: All surveyed - 1,000, WeChat Pay - 901, Alipay - 944, China UnionPay - 452, Others - 23

Source: Kagan China online adult consumer survey, July 2019

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Source: S&P Global Market Intelligence

## Attitudes towards new technology per mobile payments provider, China

(% of each mobile payments provider)



Questions: Which of the following best reflects your plans for replacing your current smartphone? How long have you had your current smartphone? Which of the following best represents your attitude when products featuring new technology are introduced?

Base: All surveyed - 1,000, WeChat Pay - 901, Alipay - 944, China UnionPay - 452, Others - 23

Source: Kagan China online adult consumer survey, July 2019

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## Age distribution per mobile payments provider, China (% of each mobile payments provider)



Questions: What is your gender? For classification purposes, please enter your age below. Which of the following best describes where you live? What is your total monthly household income?

Base: All surveyed - 1,000, WeChat Pay - 901, Alipay - 944, China UnionPay - 452, Others - 23

Source: Kagan China online adult consumer survey, July 2019

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## Highest level of education per mobile payments provider, China

(% of each mobile payments provider)



Questions: What is your gender? For classification purposes, please enter your age below. Which of the following best describes where you live? What is your total monthly household income?

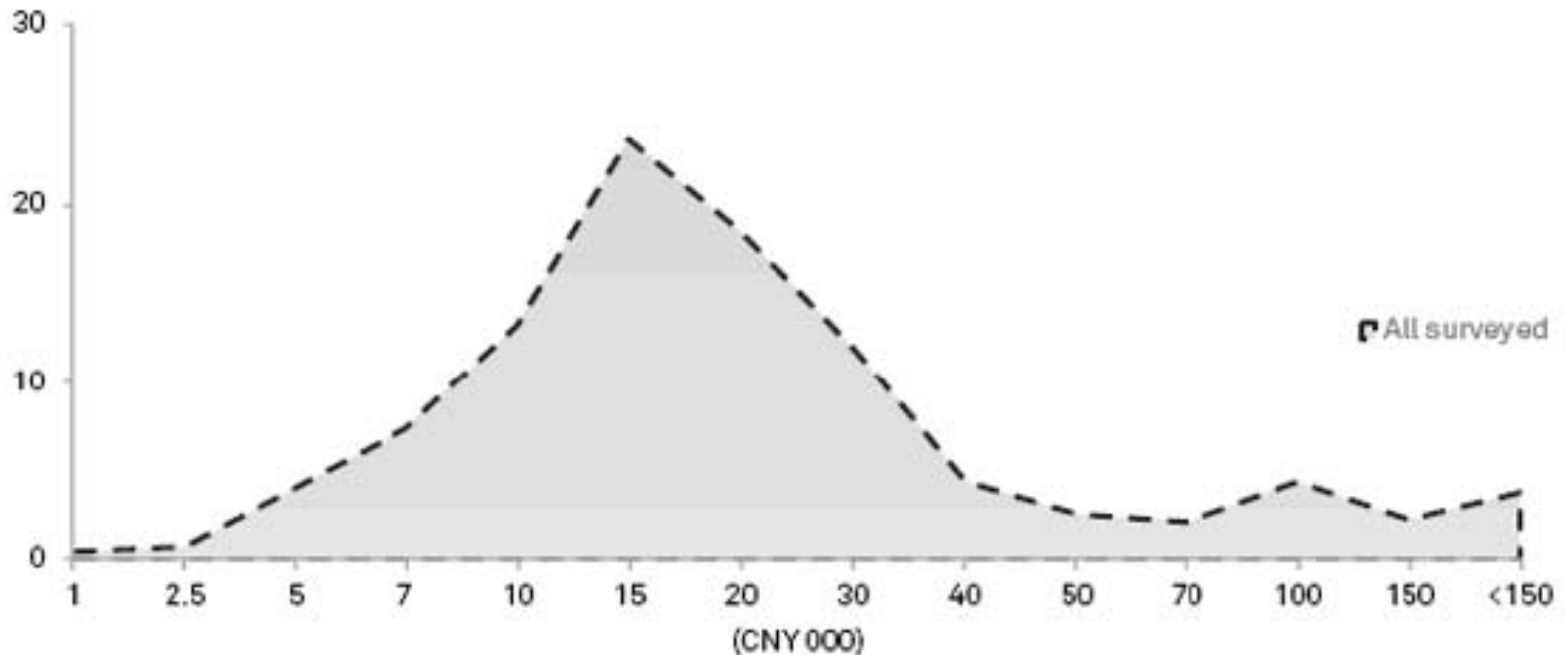
Base: All surveyed - 1,000, WeChat Pay - 901, Alipay - 944, China UnionPay - 452, Others - 23

Source: Kagan China online adult consumer survey, July 2019

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## Monthly household income per mobile payments provider, China (% of each mobile payments provider)



Questions: What is your gender? For classification purposes, please enter your age below. Which of the following best describes where you live? What is your total monthly household income?

Base: All surveyed - 1,000, WeChat Pay - 901, Alipay - 944, China UnionPay - 452, Others - 23

Source: Kagan China online adult consumer survey, July 2019

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Source: Kagan China online adult consumer survey, July 2019

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Source: S&P Global Market Intelligence

# Alipay



- 3 types of Alipay Customer/ Client accounts, each with different User Authentication/ Account Registration requirements:

Account Type	Payment Service	Payment Limit	Authentication Method
Type 1	Consumption Transfer	1,000 RMB in total	At least one online authentication channel
Type 2	Consumption Transfer	100,000 RMB/ a year	Face-to-face authentication/ At least three online authentication channels
Type 3	Consumption Transfer Investment	200,000 RMB/ a year	Face-to-face authentication/ At least five online authentication channels

- Users need to provide different types of information to the system to help them be classified into three categories. Sign-up steps include: filling a personal information questionnaire, Uploading a picture of the user's ID card and binding to his/her bank card.
- Alipay keeps the User name, Gender, Address, Contact Info and State ID number on file.
- Serves ~50% of all Small and Medium-sized enterprises (SMB) in China
  - ◆ boasts it so-called 310 program: 3-min application, 10-min approval and Zero human interaction.

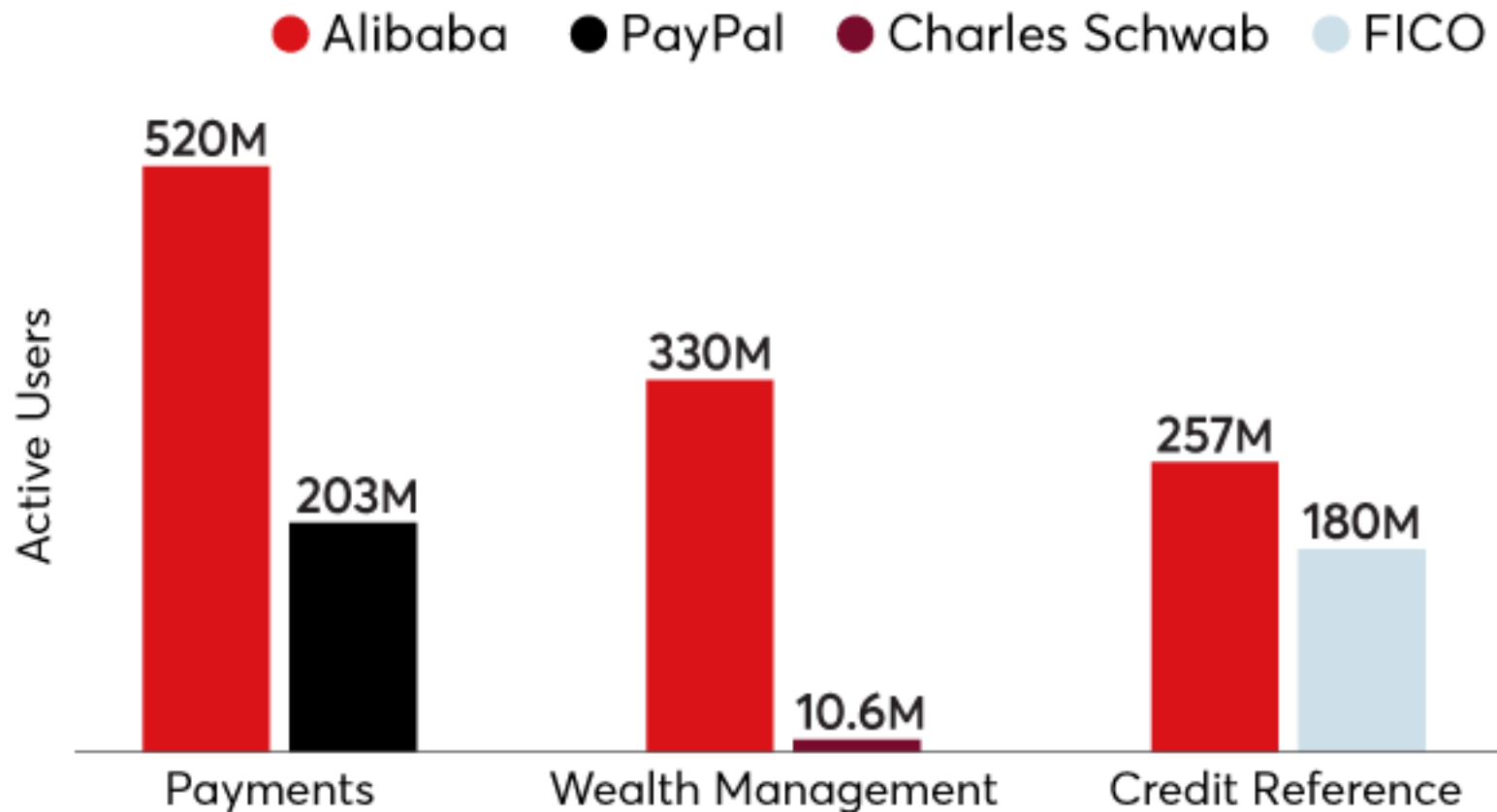


Time	Events
12/8/2004	Alipay was formally established.
12/26/2005	Alipay's "Online Inquiry System" was launched.
10/24/2006	The Industrial and Commercial Bank of China issued the Client Transaction Trusteeship Report for Alipay
8/2/2007	Alipay launched the "Internet Trust Scheme" on behalf of its over 300,000 enterprise and 44 million individual users.
10/25/2008	The platform for utilities payment was launched.
11/11/2009	Alipay formally launched its mobile payment service.
10/23/2010	Alipay and the Bank of China jointly announced its latest innovative product - quick payment with credit card.
5/26/2011	Alipay was the first to receive "The Payment Business License" from the People's Bank of China.
1/9/2012	Alipay sent users his or her "Payment Record for the Year Past", first of its kind in China.
6/17/2013	Yu'e Bao was officially launched. Working with Tianhong Asset Management, Alipay allows users to buy wealth management product even with RMB 1.
10/16/2014	Small and Micro Financial Services Company was renamed Ant Financial Services Group.
12/12/2015	Ant Financial launched the "1212" global shopping carnival.
4/26/2016	Ant Financial announced that it has completed its USD 4.5 billion Series B fundraising. It also declared international, rural and green finance as its strategic focuses.
1/19/2017	Ant Financial and the UNEP worked together to initiate the Green Digital Finance Alliance at the World Economic Forum in Davos, Switzerland.
6/25/2018	AlipayHK and GCash launch cross-border remittance service powered by Ant Financial.

# Market Power of Chinese Digital Finance Platforms

## Market power

Alibaba is a financial services force in Asia with customer reach that far outstrips counterparts in the U.S.



Source: Alipay Investor Day Presentation 2017; Oliver Wyman research and analysis

# Rate of Mobile Payment Transactions: US vs. China

“JPMorgan every year, as we speak, processes through our QuickPay, **94M** payments. But Tencent over Chinese New Year, in five days, processed **46B** payments. Basically that means **800M** payments per hour.

Visa has a maximum capacity of processing 25,000 payments per second. But Alipay can process 50,000 payments, twice as much, per second »

Jing Ulrich,  
vice chairman Asia Pacific JPMorgan Chase  
August 2017 – Rise conference/HK

# WeChat is catching up on Payment services

Launched 2009

Launched 2013



**53.7%**

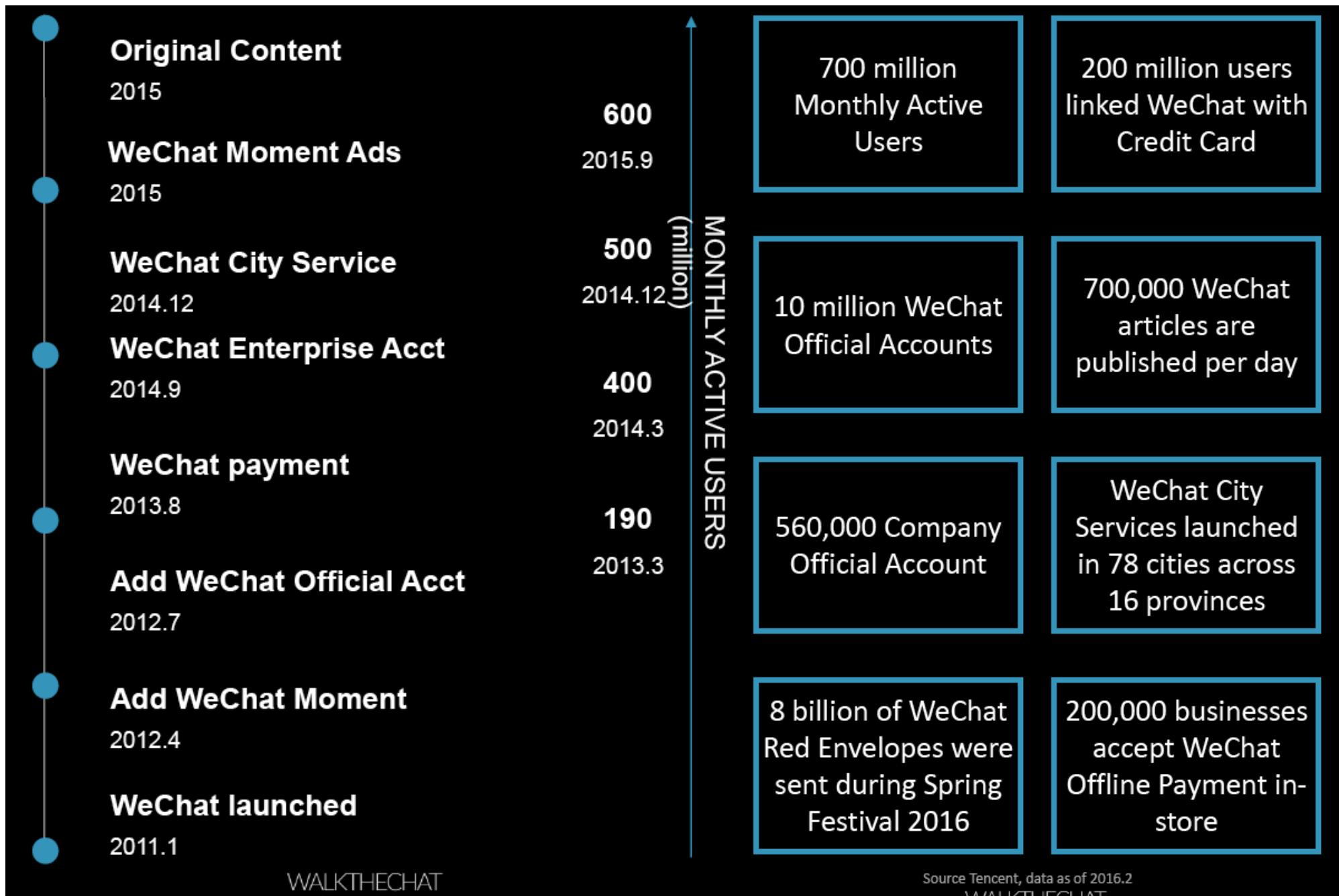
520M users

**39.3%**

600M users for WeChatPay  
+980M for WeChat

Source: Analysys  
Market share Q3 2017

# The Evolution of WeChat and Status (circa 2016)



# Presence of WeChat (circa 2016)

## Hardware Manufacture

- WeChat hardware

## Startups

- Open platform
- Co-working space

## Agriculture

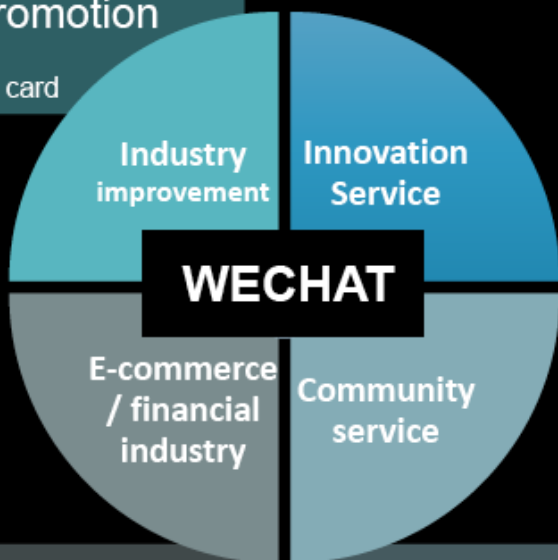
- Agriculture customization
- Authentic verification system

## AI

- Smart device
- AI software

## Business promotion

- Smart mall
- WeChat credit card



## Financial Service

- WeChat Payment
- WeChat bank

## Communication service

- WeChat life
- Government service

## E-commerce

- JD.COM
- Weidian
- Cross-border shops

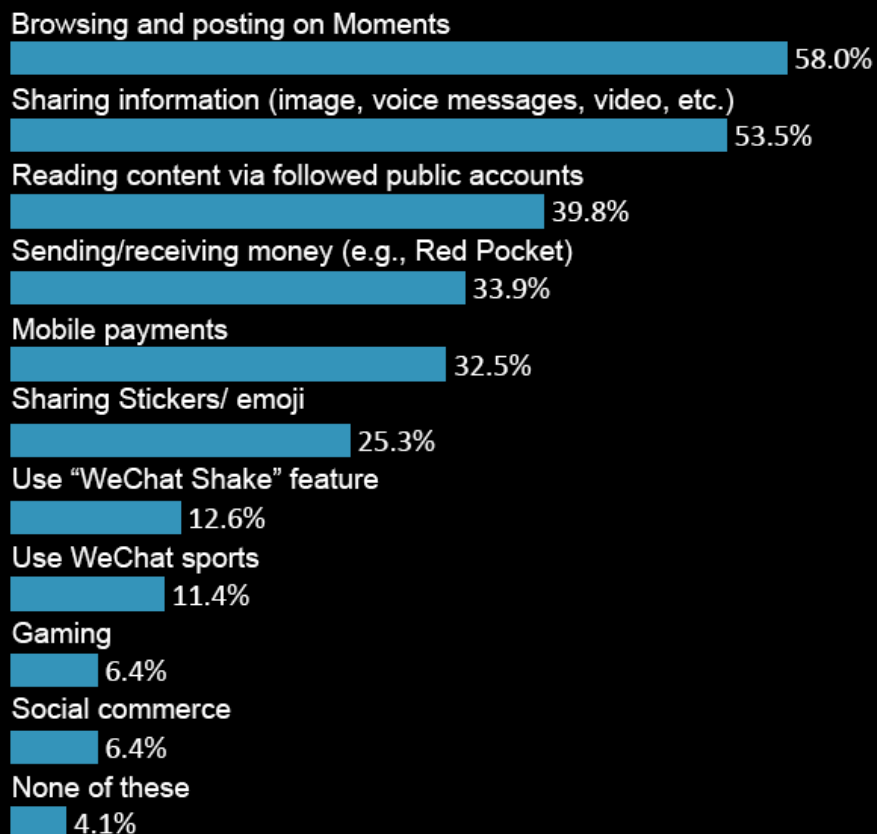
## Transportation

- Didi Dache
- Ticket service

## Top 10 things people do on WeChat

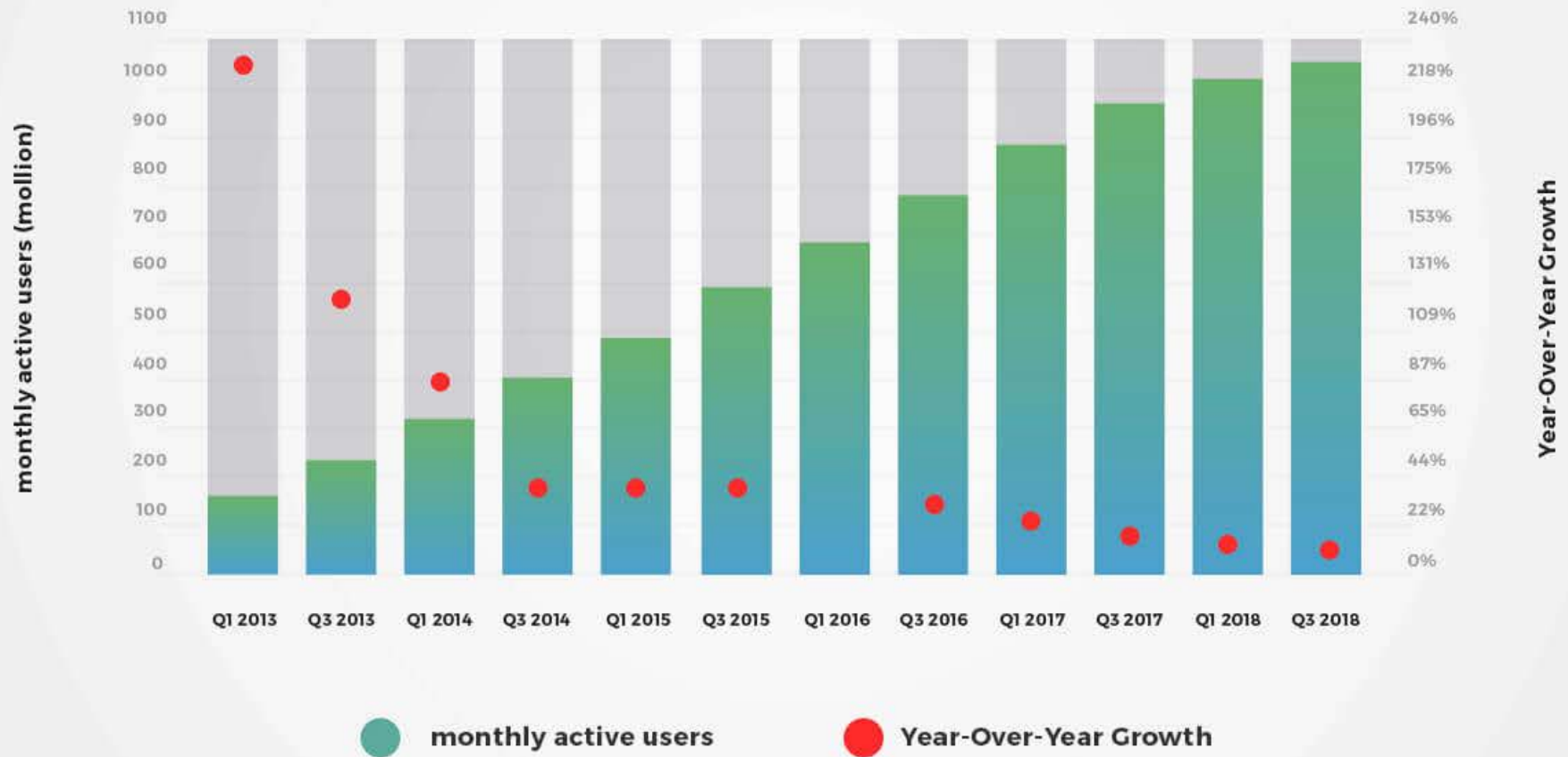
### WeChat Activities Conducted Daily by WeChat Users in China, March 2016

% of respondents



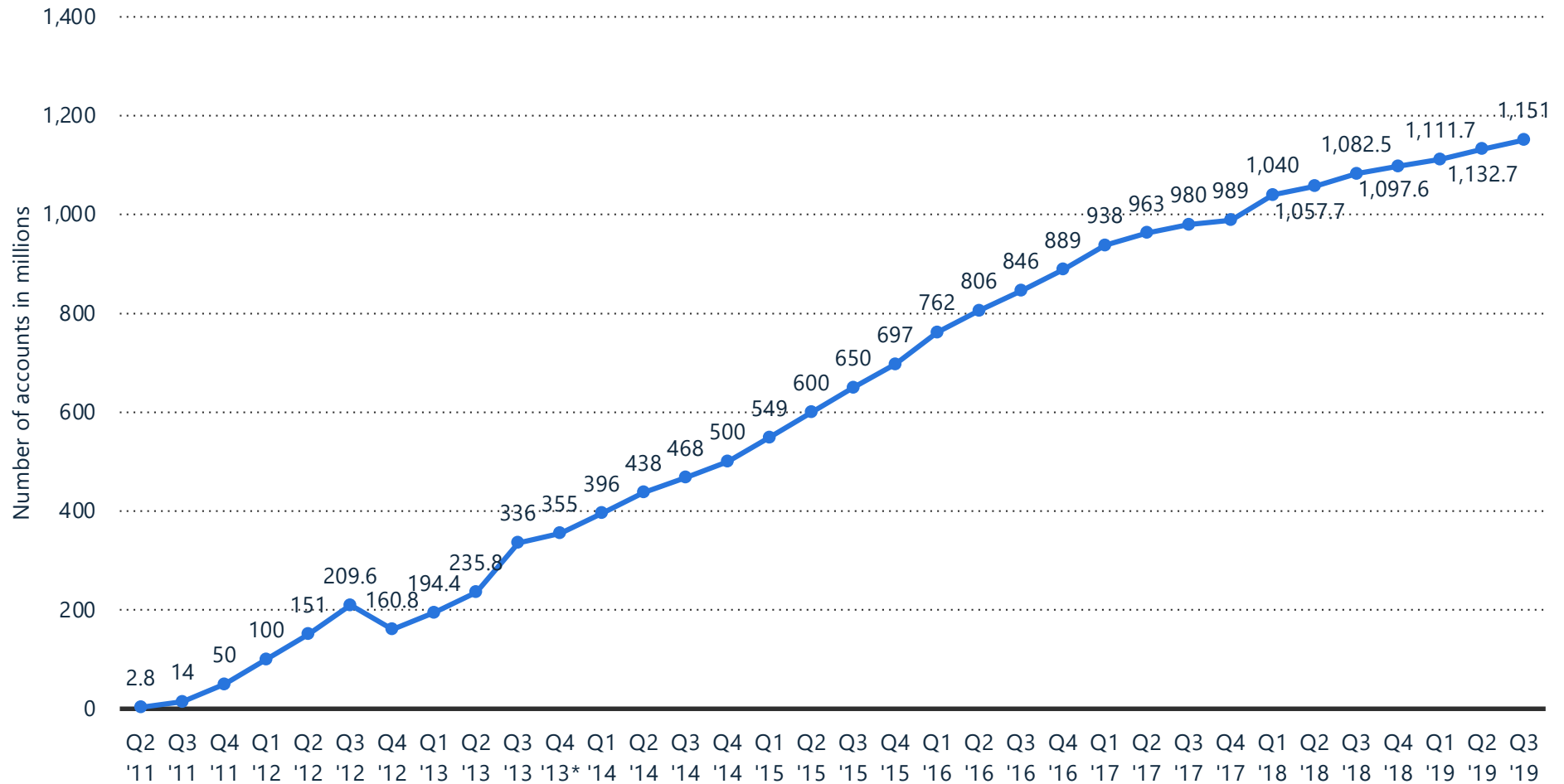
Source: Tencent Penguin Intelligence and China Academy of Information and Communications Technology (CAICT)

# Wechat's user growth through time



# No. of monthly active WeChat users from 2011Q2 to 2019Q3 (in millions)

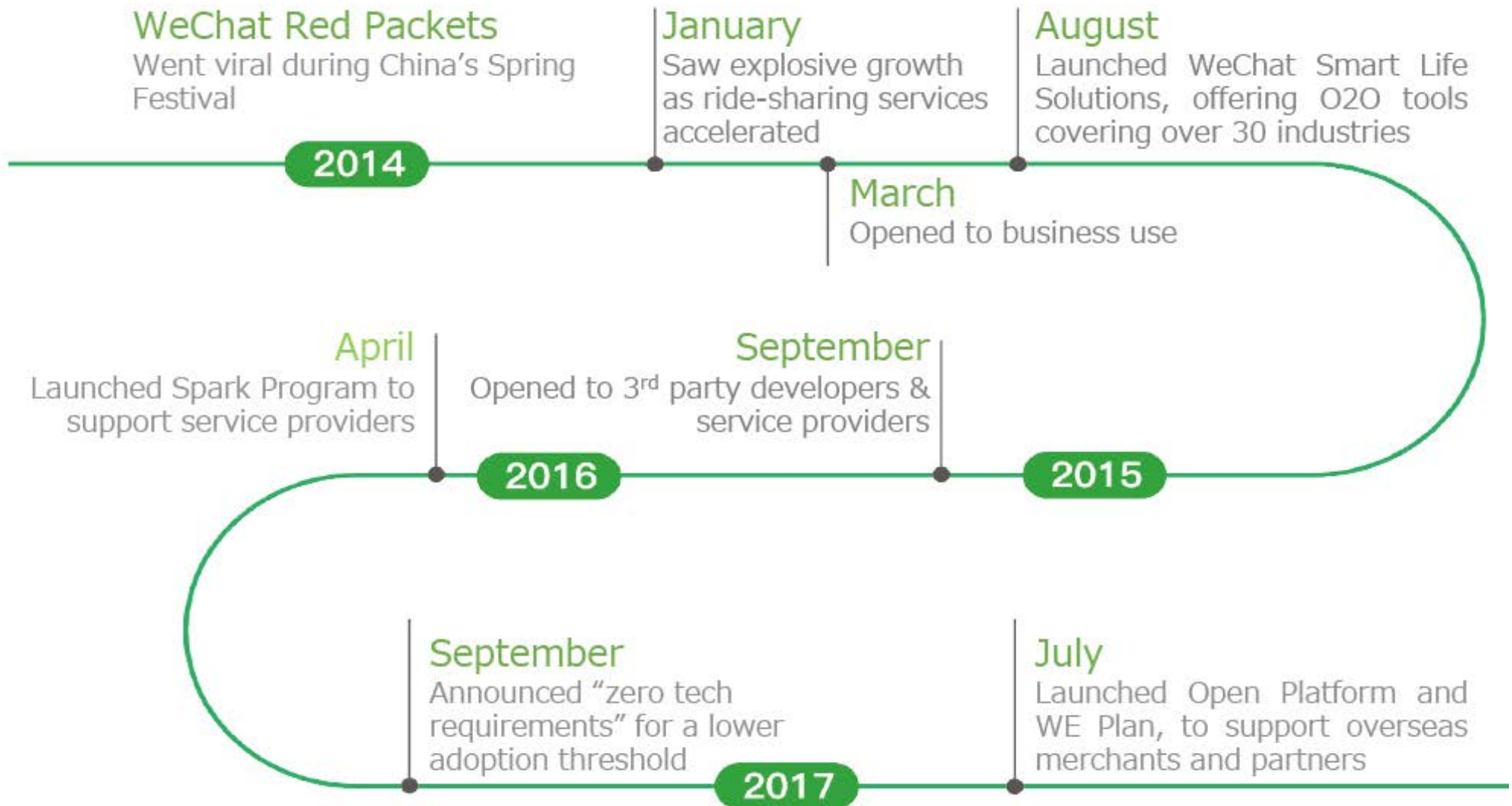
Number of active WeChat messenger accounts Q2 2011-Q3 2019



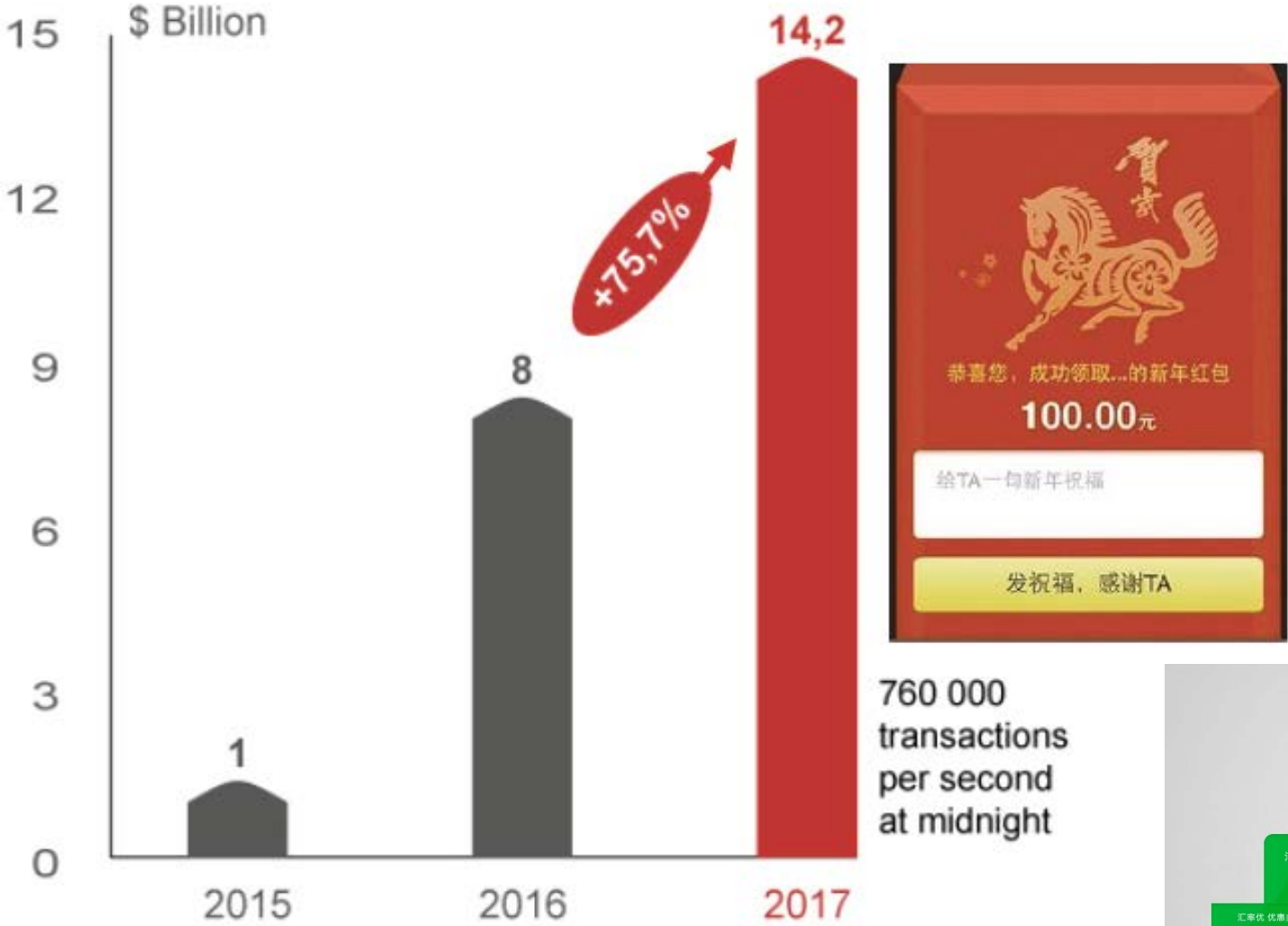
**Note:** China; Q2 2011 to Q3 2019; MAU of Weixin and WeChat  
 Further information regarding this statistic can be found on [page 8](#).  
**Source(s):** Tencent; China Internet Watch; [ID 255778](#)



# The Story of WeChat Pay and Smart Life



# Red Packet Campaign in CNY eve contributed to rapid growth of WeChat Pay



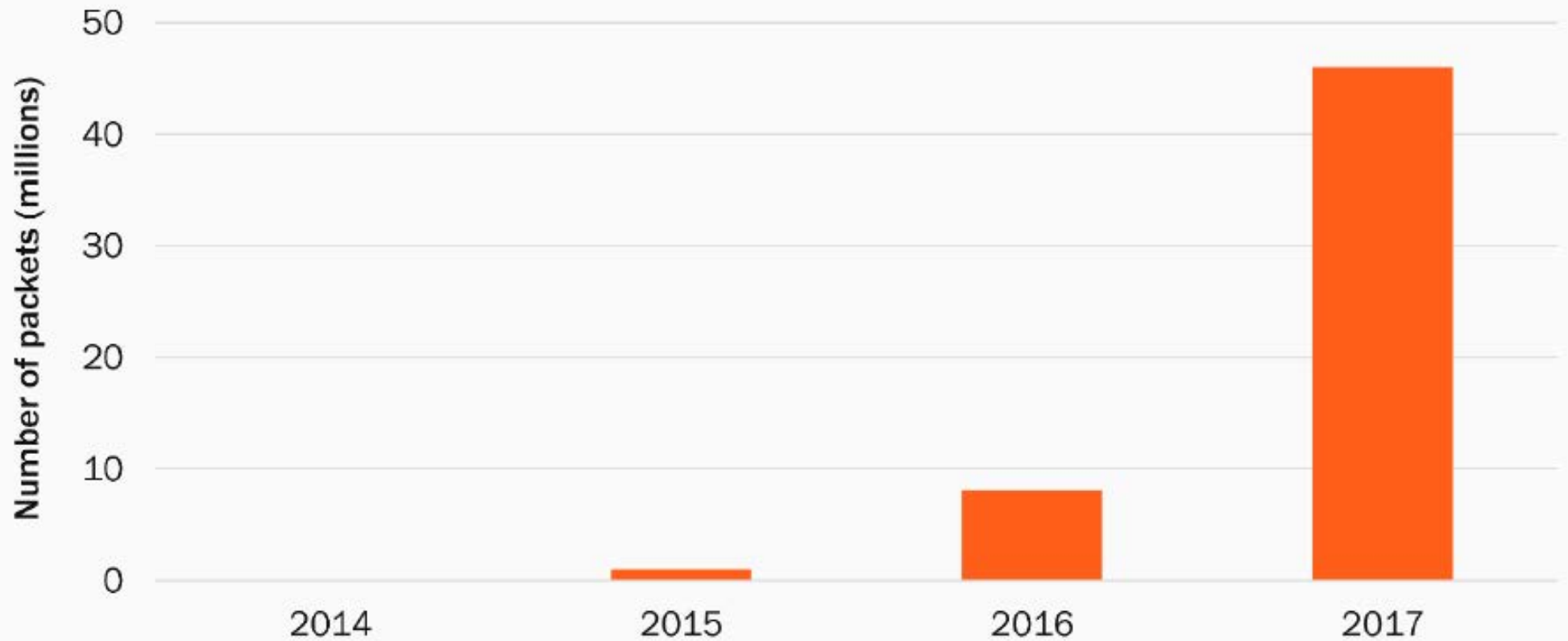
760 000 transactions per second at midnight



WeChat also provided coupons and red packet incentives for offline purchases.

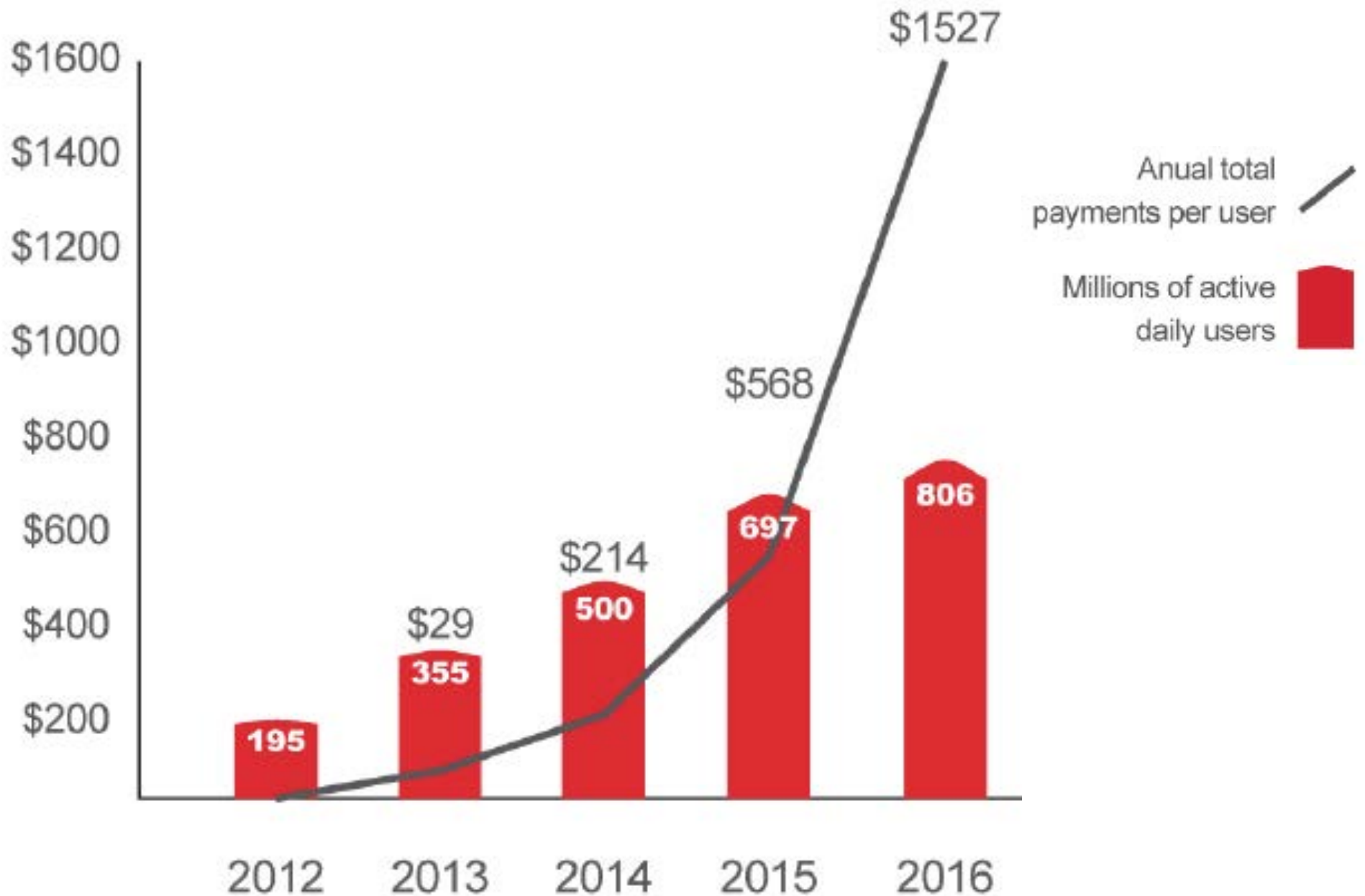
# Red Packets as the Marketing tool

**Total Red Packets exchanged via WeChat (millions)**



**Source:** The Lowdown

# Growth of WeChat Pay vs. WeChat

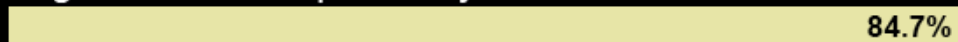


# Red envelope is the most popular payment feature

## WeChat Mobile Payment Functions Used by WeChat Users in China, March 2016

% of respondents

Digital Red Envelope money



Making Payments



Money transfer to contacts



Receivable



WeChat credit card \*



Pay off credit card



Splitting payment with friends (e.g., for restaurant bills)



None of these

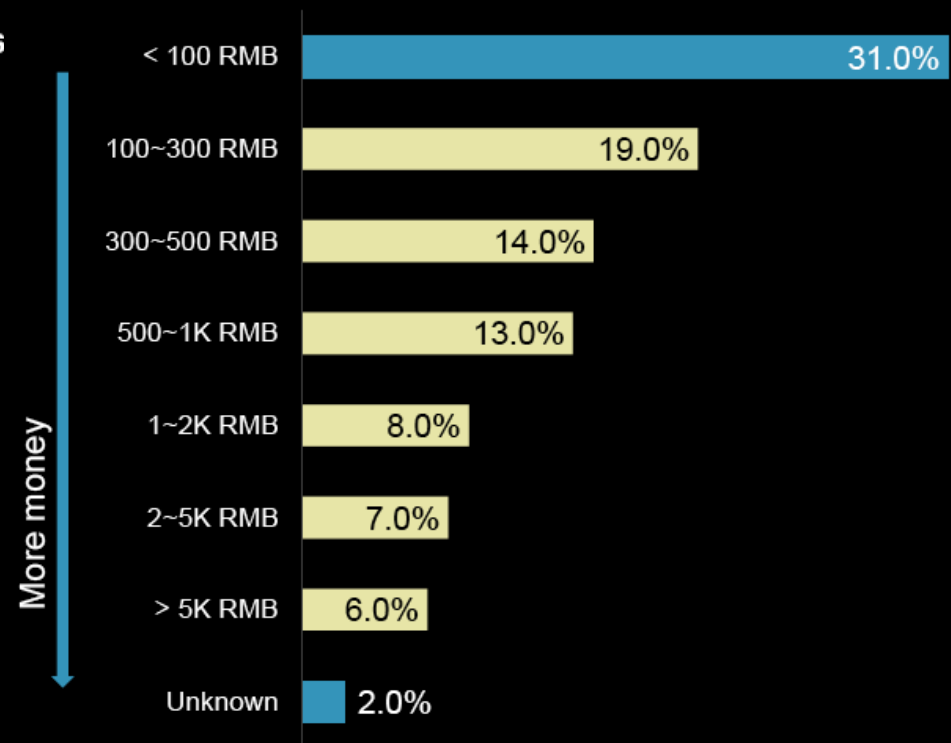


Note: \*payment processed via scanning a QR code generated by an app  
Source: Tencent Penguin Intelligence

# Near 70% of users spend more than 100 RMB per month

## Monthly Average Amount That WeChat Users Pay/Transfer

% of respondents

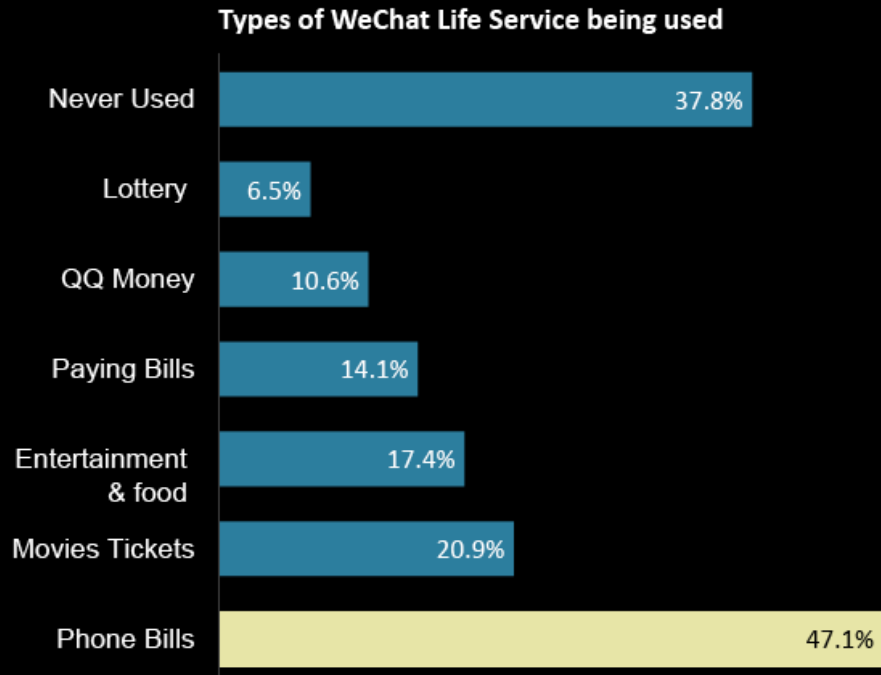


More money

Note: excluding non-WeChat payment users.  
Source: WeChat Economics Social Influence Analytical Report

- 67% of users spend over 100 RMB per month, more than doubled from last year.
- 34% of users spend over 500 RMB per month, six times more than last year (5%).

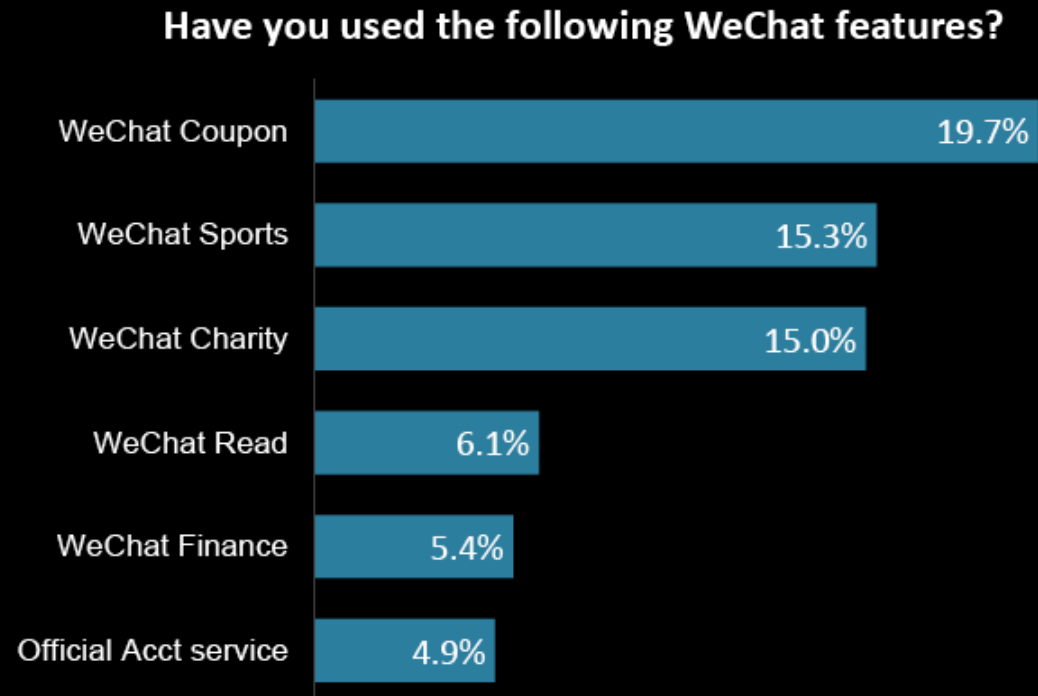
## Over 60% of the WeChat users have used WeChat life service



Source: WeChat Economics Social Influence Analytical Report; Tencent Penguin Intelligence China Academy of Information and Communications Technology (CAICT)

- Most users use WeChat Life Service to pay for phone bills. The scope of service are also expanding to entertainment and buying movie tickets.

## Sports, Charity, and other services are booming



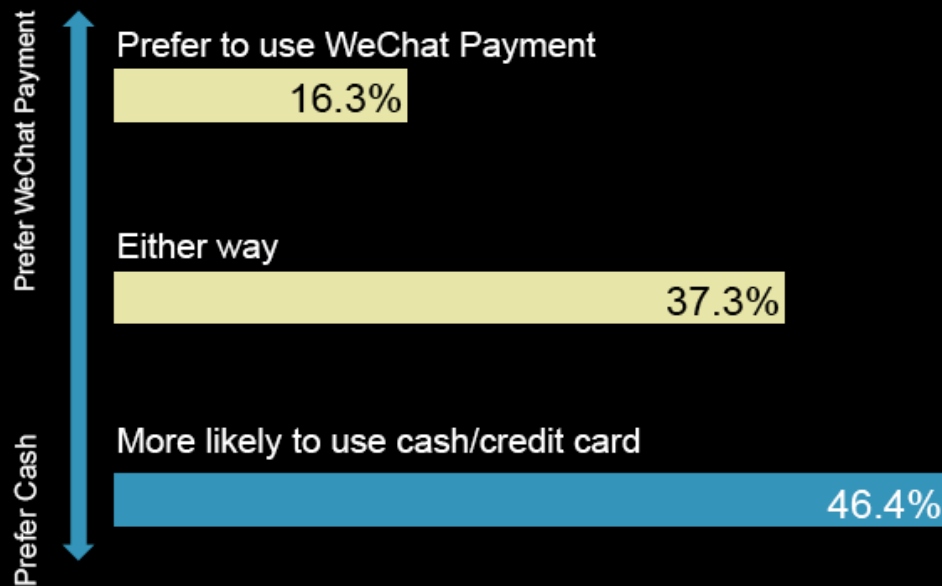
Source: WeChat Economics Social Influence Analytical Report; Tencent Penguin Intelligence and China Academy of Information and Communications Technology (CAICT)

- WeChat is also expanding in other areas including coupons, charities, and sports

## WeChat Payment Vs. Conventional Payment Strong Willingness to Use WeChat Payment

Which payment method do you prefer: WeChat payment or cash/credit card?

% of respondents



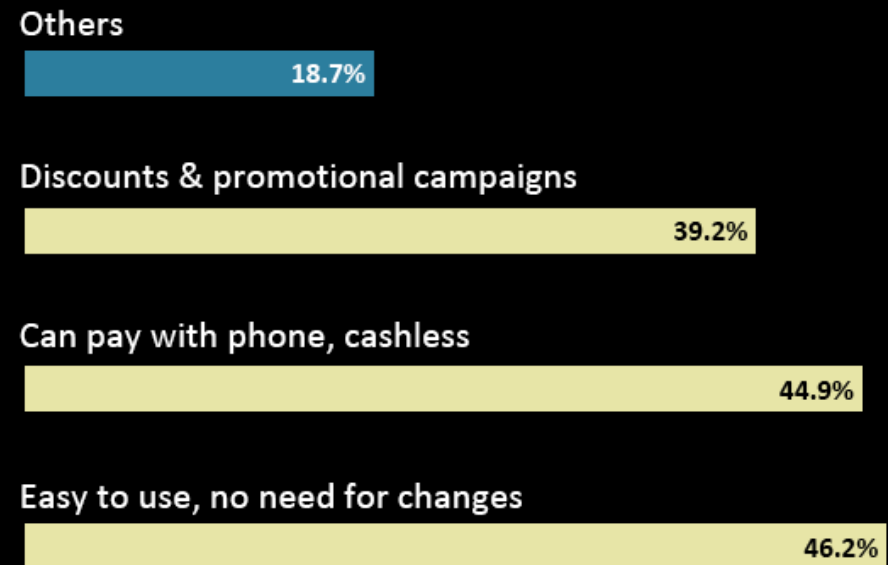
Note: sample size: 31349, excluding WeChat users with no offline payment experience.  
Source: Tencent Penguin Intelligence

- **53.6%** of customers indicates they would consider paying with WeChat when given the option.

## Main reasons to use WeChat offline payment: ease, convenience, promotions

Why do you choose to use WeChat for offline payment?

% of respondents



Note: sample size: 31349, excluding WeChat users with no offline payment experience.  
Source: Tencent Penguin Intelligence

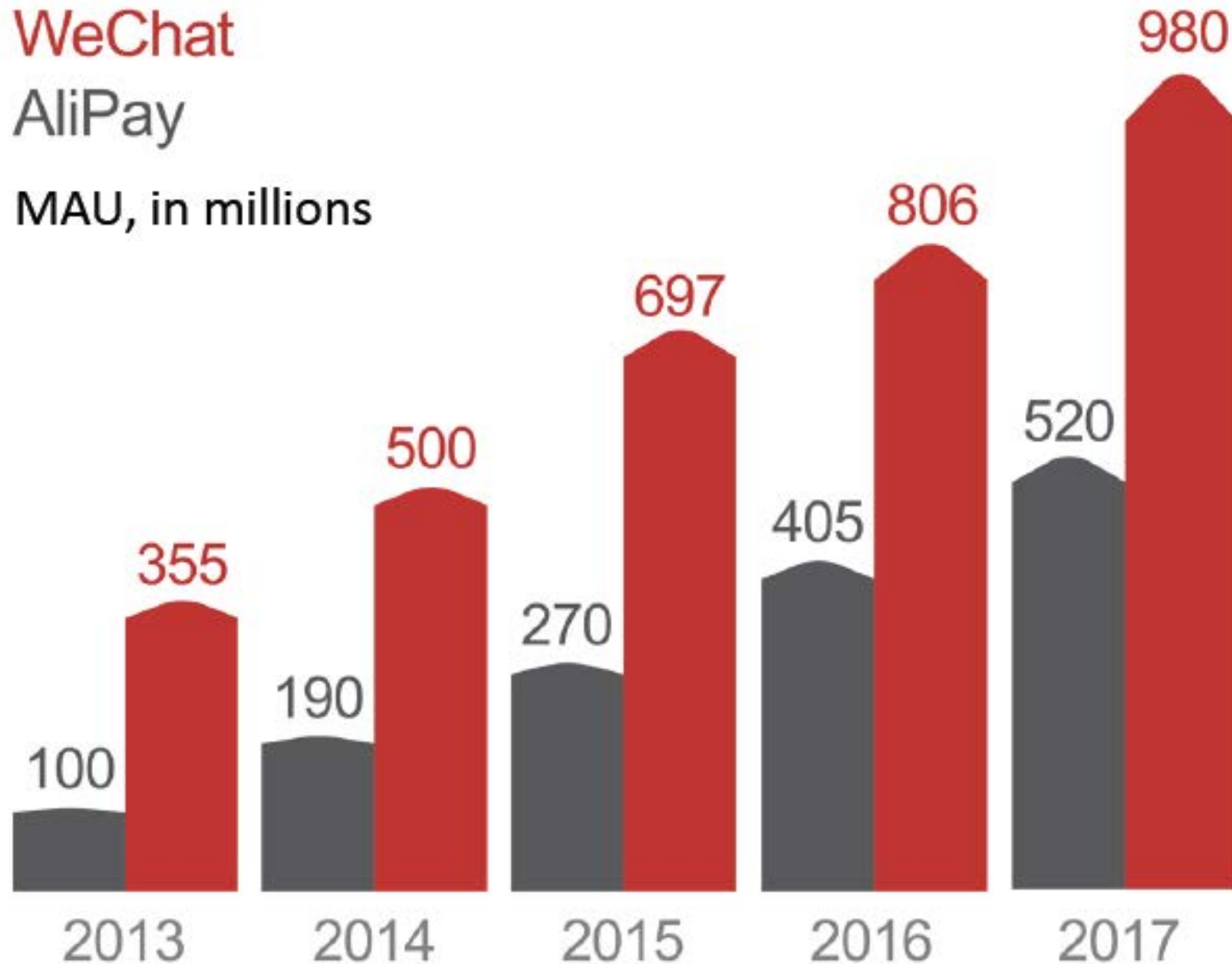
- Users choose to use WeChat payment because it is easier, more convenient and occasionally have promotion discount campaign

# Alipay vs. WeChat

WeChat

Alipay

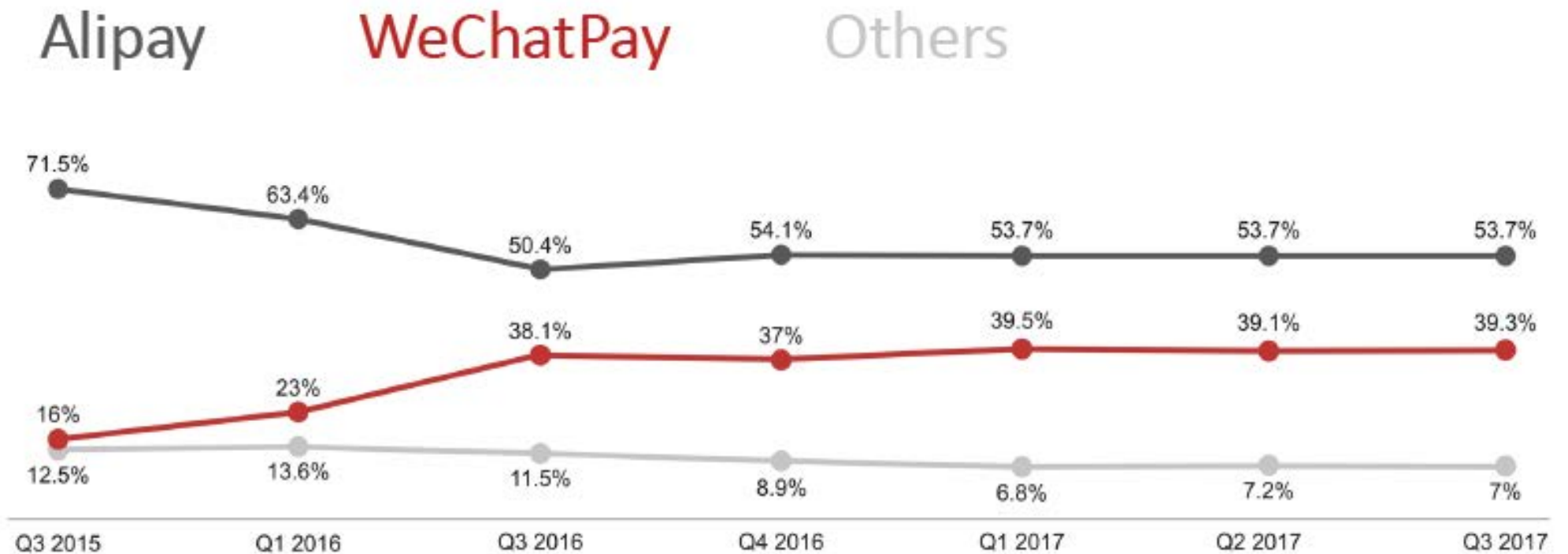
MAU, in millions



Sources: techinasia; DMR



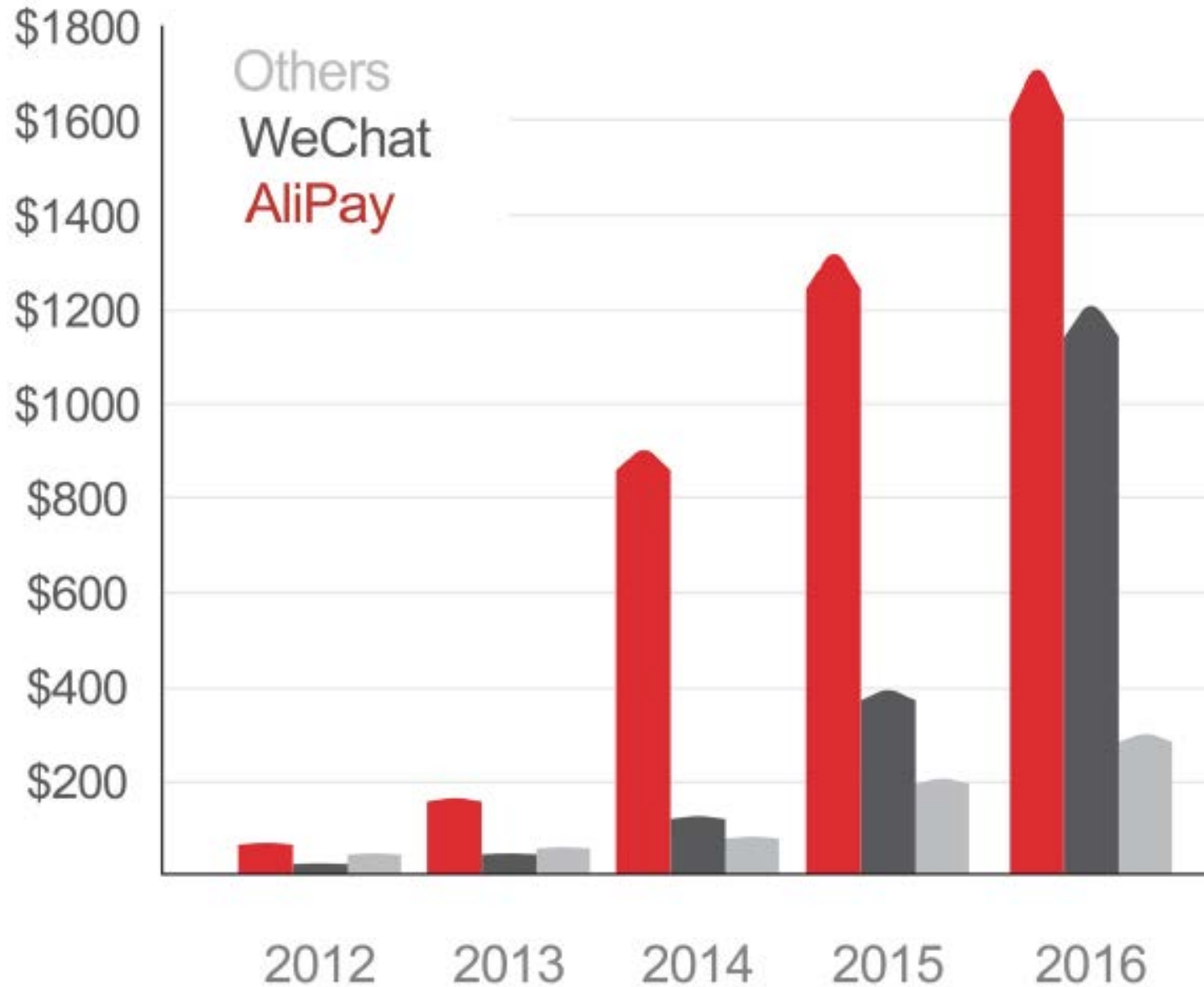
# Alipay vs. WeChat Pay



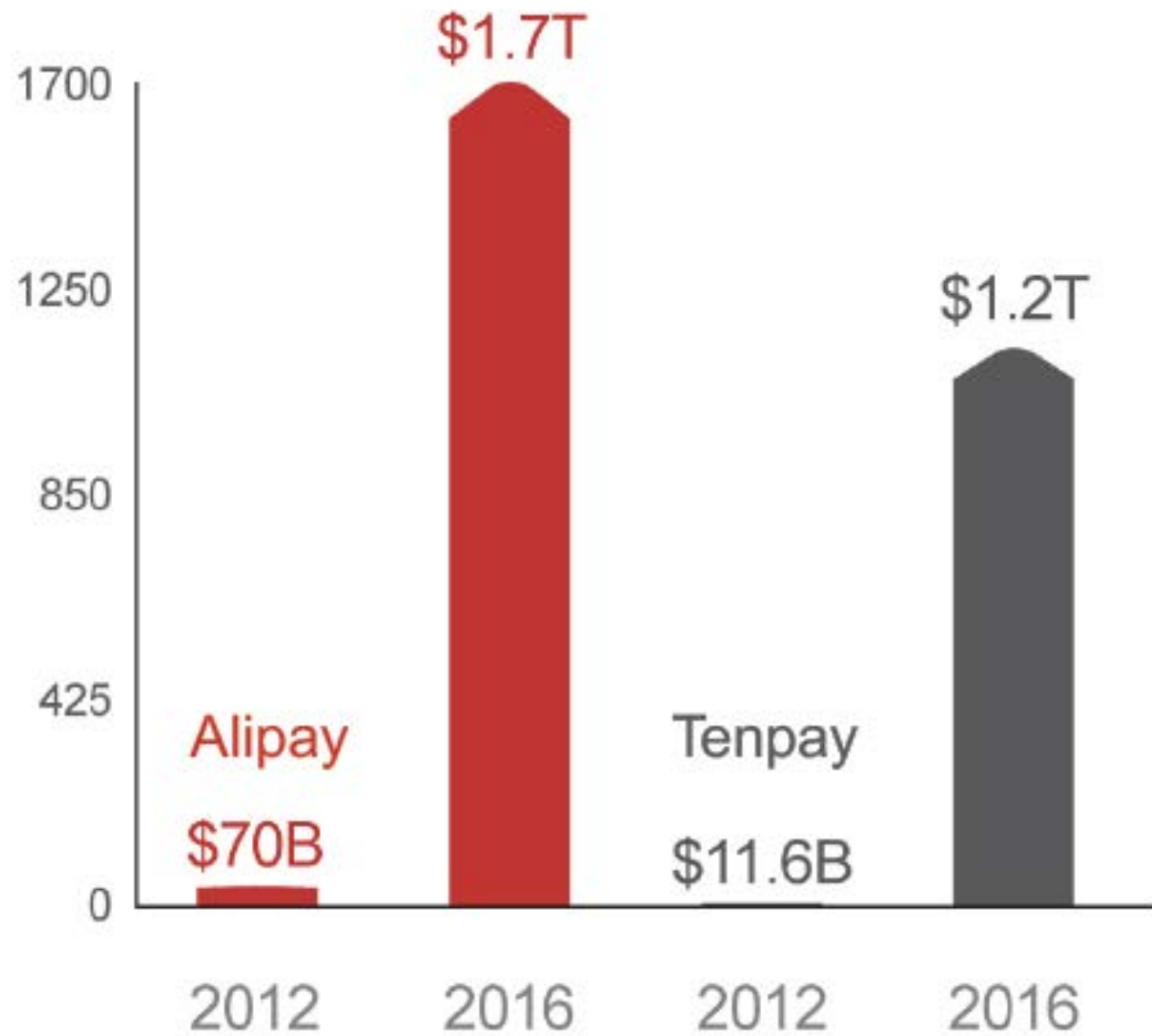
Source: Analysys  
Market share Q3 2017

# Mobile Payments by Value

mobile payments,  
billion USD

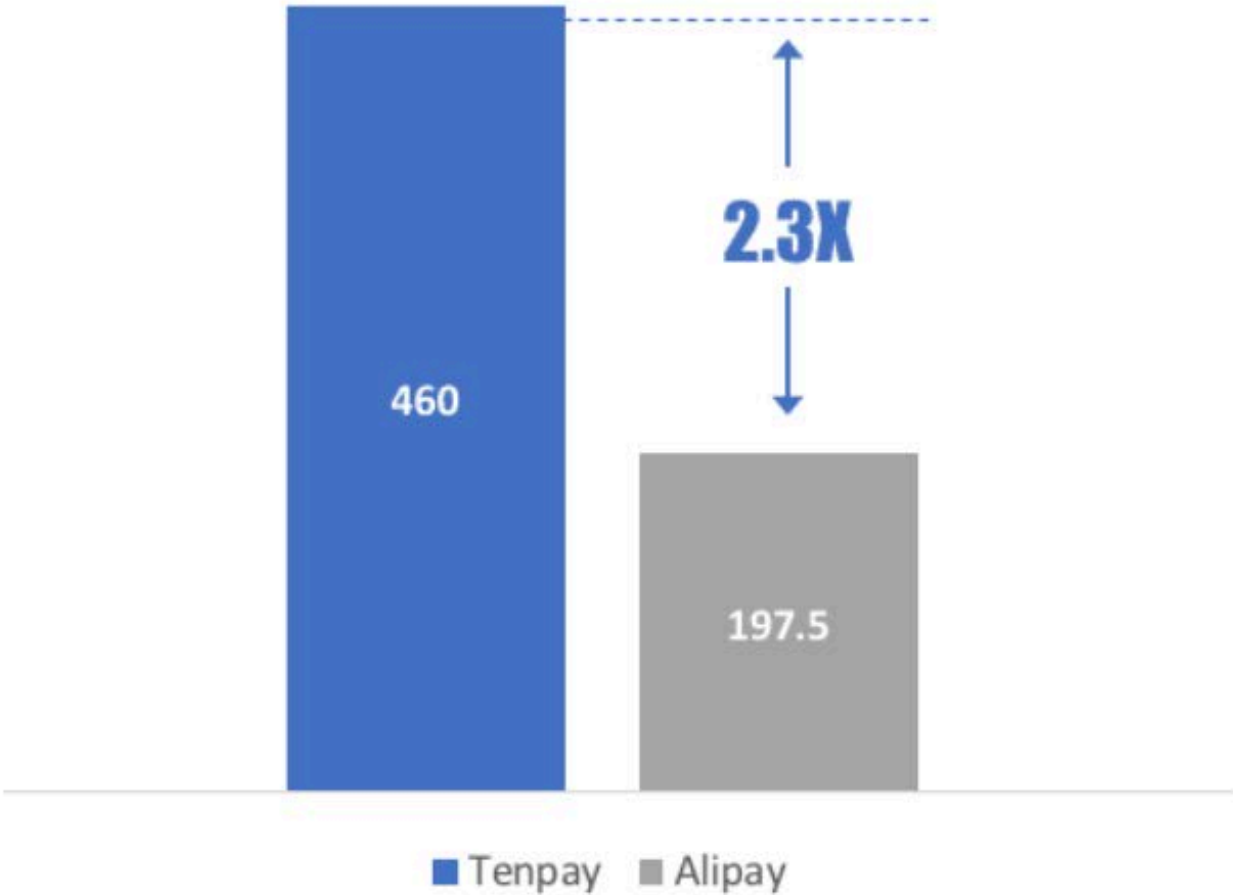


# Digital Payment Growth in China



Source: Better Than Cash Alliance

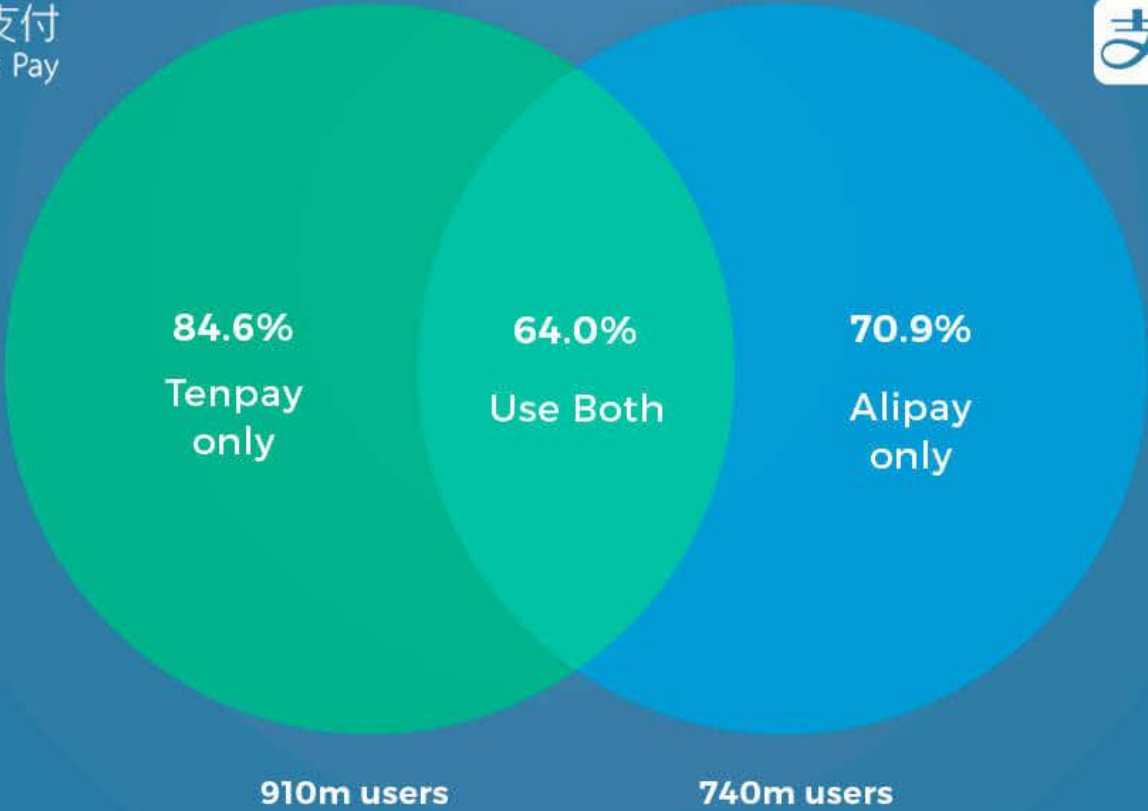
# Transaction amount in 2018 Tenpay vs. Alipay (billion)



Source: Ipsos 2018 Q4 Third-Party  
Mobile Payment User Report


WALKTHECHAT

# Tenpay and Alipay's market penetration 2018



# Wallet GUI Comparisons

## Alipay Wallet



The Alipay wallet puts some of the most frequently used payment functions near the top of the screen. Here, a user can scan another person or merchant's QR code, show their own QR code or access location-based shopping services

Pay mobile phone bills

Transfer money to other contacts

Red envelope, a Chinese tradition, sending cash to someone or a group of people as gifts

Didi, the Chinese equivalent of Uber, internet taxi service

Charity services, requiring users to accomplish tasks, after certain level the charity will plant trees as rewards

Lottery

Contacts

Provides an overview of some of the key technologies and projects Ant Financial is working on

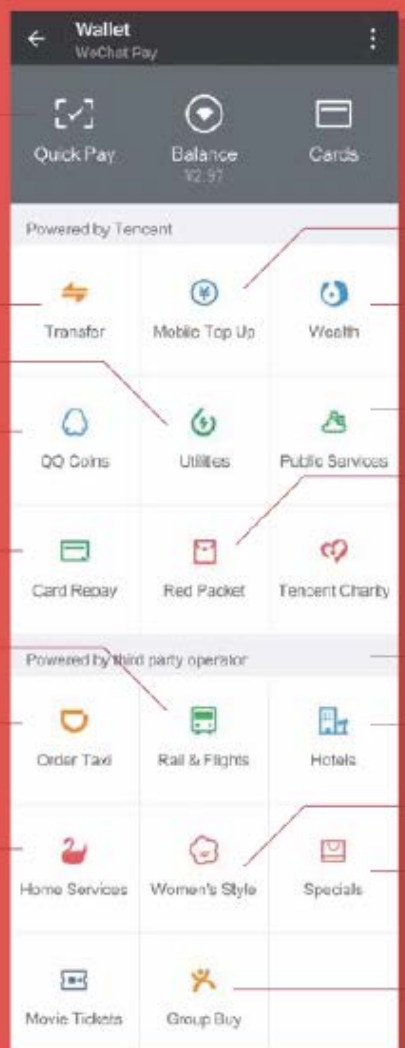
Wealth management products

Wealth management service including Yu'eBao

Purchase movie tickets online

Pay Utility bills such as gas, etc.

## WeChat Wallet



Similarly to Alipay, the WeChat wallet provides access to frequently used payment functions including Quick Pay, which shows the user's QR code

Pay mobile phone bills

Wealth management products

Access to public services, depending on the city, including government affairs, life services, transportation, etc.

Red envelope, a Chinese tradition, sending cash to someone or a group of people as gifts

As part of the WeChat ecosystem, select 3rd party developers are able to create applications that run on the WeChat wallet and give users access to additional products and services

Cooperation with "YiJiang," booking hotels online

Cooperation with Mellishuo, selling women's clothes and cosmetics, etc. online

Cooperation with JingDong online E-commerce service

Group buying service where users can take advantage of special discounts on products and services

Transfer money to other contacts

Pay Utility bills such as gas, etc.

QQ coin (Tencent's digital currency) purchase, can be used in games and other services

Credit card repayment from WeChat wallet

Purchase train or flight tickets through the WeChat wallet

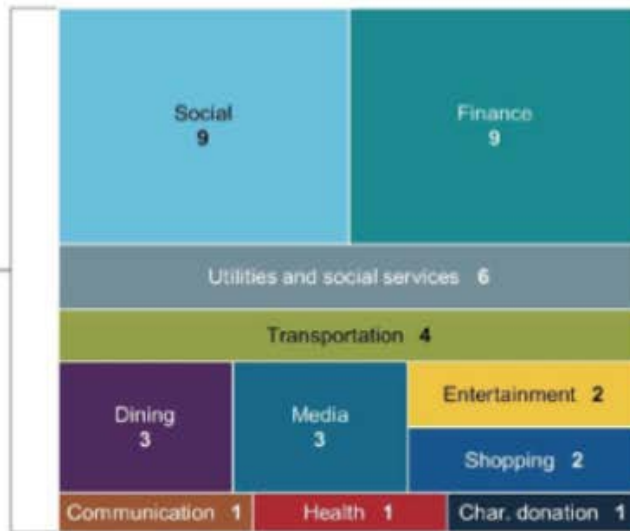
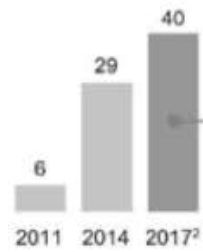
Didi, the Chinese equivalent of Uber, internet taxi service

Homes services such as cleaning and repair provided through a 3rd party company

# Strength Comparison in Service Sectors



WeChat



Alipay



# Comparison of Major Mobile Payment Systems

	TPC-Led				Bank-led		
	Alipay		Wechat Pay		Apple Pay	Google Pay	Samsung Pay
Payment method	Near-field	remote	Near-field	remote	Near-field	Near-field	Near-field
Compatibility	System support only	System and hardware	System support only	System and hardware	System and hardware	System and hardware	System and hardware
Hardware cost	Low	High	Low	High	High	Medium	High
Payment range	0.1-0.6m		0.1-1m		0.04-0.1m	0.04-0.1m	0.04-0.1m
Tokenization system	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized	Centralized
Payment communication	QR code and Audio	Internet	QR code	Internet	NFC	NFC	NFC and MST
Interactive	×	✓	×	✓	✓	✓	✓
TEE	✓	✓	✓	✓	✓	✓	✓
SE	×	×	×	×	rSE	HCE	rSE
Payment authentication	TOTP	PIN or biometric	TOTP	PIN or biometric	PIN or biometric and EMVCo,TOTP	PIN or biometric and EMVCo,TOTP	PIN or biometric and EMVCo,TOTP
Sensitive information	Unprotected hardware	Local SE	Unprotected hardware	Local SE	Local SE	Cloud SE	Local SE
Anti-eavesdropping attack resistance	×	✓	×	✓	✓	✓	✓
Relay attack resistance	×	×	×	×	×	×	×
Password guessing attack resistance	✓	✓	✓	✓	✓	✓	✓
Root or jailbreak attack resistance	×	×	×	×	✓	✓	✓
Stolen device attack resistance	×	✓	×	✓	✓	✓	✓
Man in the middle attack resistance	×	×	×	×	×	×	×
Low communication overhead	✓	×	✓	×	×	×	×
Low computation overhead	✓	×	✓	×	×	×	×
Secure mutual authentication	×	✓	×	✓	✓	✓	✓

Source: W. Liu et al, State of the Art: Secure Mobile Payment, IEEE Access Vol. 10, 2019.



# Presences of Chinese Digital Finance Platforms in different Service Sectors

FUNCTIONALITY	 Alibaba Group	 Tencent 腾讯	 Baidu 百度	 中国平安 PING AN	 JD 京东 JD.COM	 Xiaomi
PAYMENT	Alipay	Tenpay, WeChat Pay	Baidu Wallet	1qianbao	JD Payment	Xiaomi Pay
LENDING	Ant Micro Loan, Huabei	Weilidai, Renrendai	Baiduxiaodai	Changyi, Puhui	JD IOU	
BANK	MyBank	WeBank	Baixin Bank	PingAn Bank		
INSURANCE	ZhongAn Insurance, Cathay Insurance	ZhongAn Insurance	BaiAn Insurance	PingAn Insurance, ZhongAn Insurance	JD Insurance	
SECURITIES	Tebon Securities	Futu, Huatai		PingAn Securities		Tiger Securities
WEALTH MANAGEMENT AND DISTRIBUTION	Tianhong, Yu'E Bao, Ant Jubao Shumi Taojin 100 Index	Howbuy.com, Licaiton	Baifa, Baizhuan	Lufax	JD Xiaojinku	Jijinbao, Huoqibao
CREDIT SCORE	Sesame Credit	Tencent Credit		Qianhai Credit		
CROWDFUNDING	Taobao Crowdfunding, Antsdaq	Tencent Lejuan		PingAn Haofang	JD Crowdfunding	Duocaito

## Payments are part of fintech and retail ecosystems

	Paytm	Walmart	Google	Amazon
<b>Payments</b>	Paytm Payments Bank offers P2P and merchant payments.	PhonePe offers P2P and merchant payments.	P2P and merchant payments.	Amazon Pay, a payment processing service owned by Amazon, operates a digital wallet in India. Invested in ToneTag, which uses sound wave to make proximity-based contactless payments.
<b>Electronic retailing</b>	Paytm Mall is a digital shopping place.	Flipkart is a digital shopping place.	Google has launched shopping search to allow users to filter products and review prices from multiple retailers. Invested in hyperlocal delivery company Dunzo and online-to-offline fashion e-commerce platform.	Amazon.in is an e-commerce company in India.
<b>Lending</b>	Online point-of-sale financing.	Online point-of-sale financing.	Partnered with four banks to facilitate pre-approved loans to their customers. Google's venture capital arm invested in micro-loan startup Aye Finance.	Online point-of-sale financing. Invested in digital lender Capital Float.
<b>Insurance</b>	Holds a corporate agency license to distribute insurance products.	Flipkart provides mobile protection insurance.	NA	Holds a corporate agency license to distribute insurance products. Invested in Acko, which offers auto policies.
<b>Other financial services</b>	Paytm Money, a registered investment adviser, offers mutual fund products.	PhonePe plans to sell mutual funds through its app.	NA	Invested in online financial services marketplace BankBazaar.

Data compiled Feb. 4, 2019.

NA = not applicable

Sources: S&P Global Market Intelligence, Business Standard, The Times of India, Mint, company disclosures

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## Alibaba's M&A road map

2015 – Alibaba acquired over 40% of Paytm, Indian's biggest online payment company, for \$900 million

2016.11 – Ant Financial invests in Thailand's Ascend Money

2017. 2 – Ant Financial extended its global reach to the Philippines by investing in Mynt, a financial venture from Globe Telecom

2017.3 – Alipay partnered with Malaysia's 2 biggest banks, Maybank and CIMB, to offer cashless payments to Chinese visitors

2017.6 – Alibaba's Ant Financial expanded to Korea with \$200M investment in Kakao Pay

2017.4 – Lazada's payment platform helloPay merged with Alibaba's Ant Financial, rebranded as Alipay. Lazada's service covers Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, and other South East China

2018.1 – Ant Financial attempted to take over US-based Moneygram for \$1.2 billion but was blocked by US lawmakers citing data privacy and security concerns

2018.1 – Ant Financial expanded mobile e-wallet service to Malaysia via Touch 'n Go

2018.3 – Ant Financial partnered with Emtel from Indonesia to release the e-wallet service DANA

2018.3 – Ant Financial invested \$184.5m in Telenor Microfinance Bank in Pakistan

2018.4 – Ant Financial invested in bKash from Bangladesh

2018.7 – Ant Financial invested US\$200 million into Korea's Kakao Pay

2019.1 – Ant Financial invested USD 40M in Indonesia's fintech lender Akulaku

2019.2 – Ant Financial acquired British payment group WorldFirst for \$700 million

# Overseas Investments/ Cross-border Expansion

## Tencent's investment plan

2017. 7 – Tencent invested around \$100 – \$150 million in Indonesian ride-hailing startup Go-Jek, the parent company of Go-Pay, a rapidly growing mobile payment service in Indonesia

2018.10 – Tencent invested \$180 million in Brazil fintech Nubank

2018.11 – Line and Tencent linked up to push cashless payments in Japan in response to Alibaba's strong Japan presence

Tencent's overall investment strategy tend to be more tangential to its core business: online media, content creation and gaming. While Alibaba has a much stronger focus in payment and supply chain.

# Ant Financial Global Payment Coverage



1. China



2. India



3. Thailand



4. Korea



5. Philippines



6. Hong Kong (China)



7. Malaysia



8. Indonesia



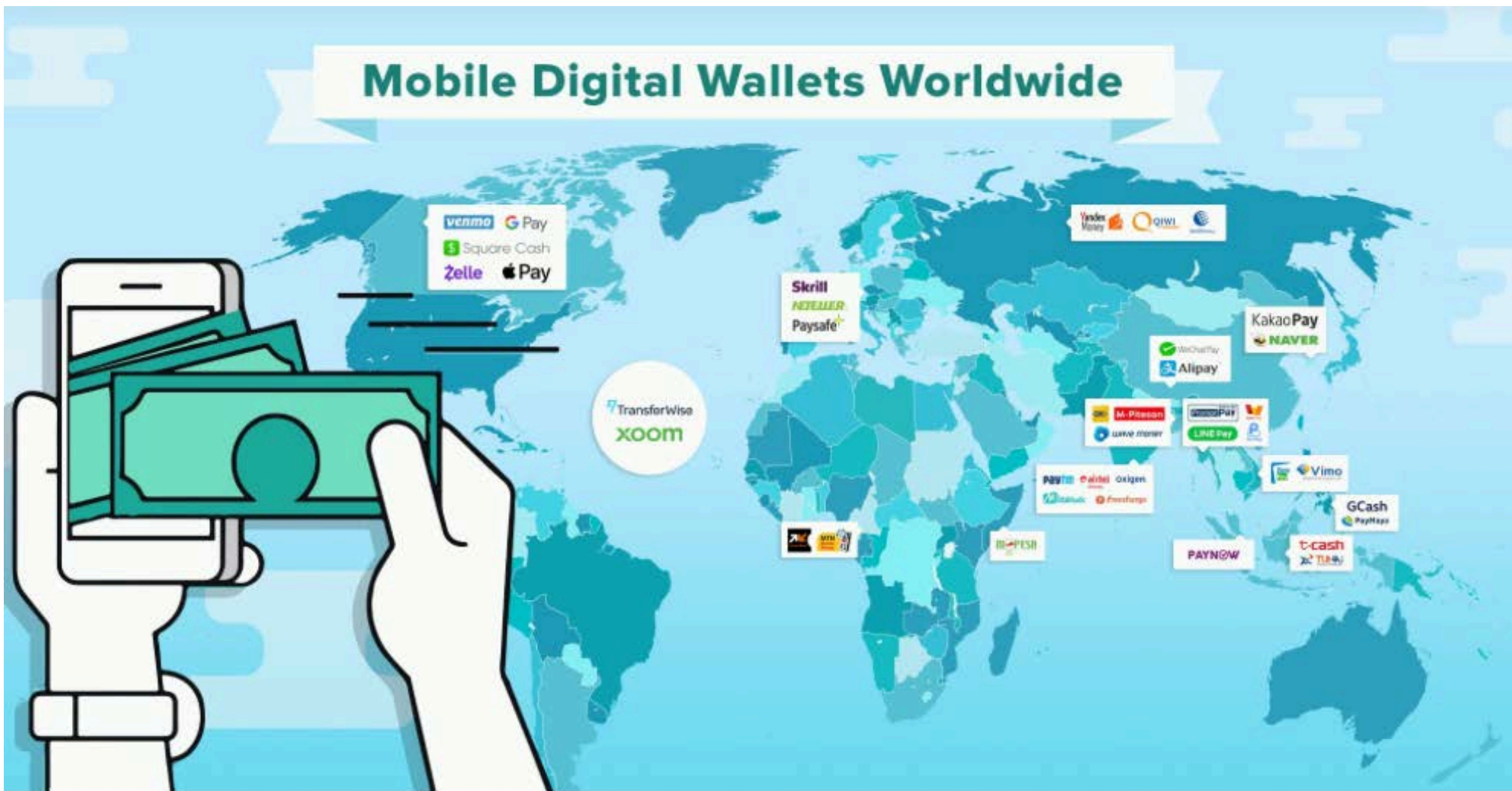
9. Pakistan



10. Bangladesh



# Recent Mobile Payment Landscape Worldwide



- As of Jan 2019, 1 Billion+ Active Mobile Digital Wallet users worldwide
  - ◆ One-in-Five connected users
  - ◆ Transactions averaging 9 Billion US\$ per day

Source: <https://medium.com/mobiletopup/digital-cash-is-here-say-goodbye-to-your-wallet-ec57b2c48058>

# E-Wallet Global Usage (circa 2020)



\* Information retrieved from Worldpay's Global Payments Report 2018

# Mobile Digital Wallets Worldwide (circa Jan 2019)

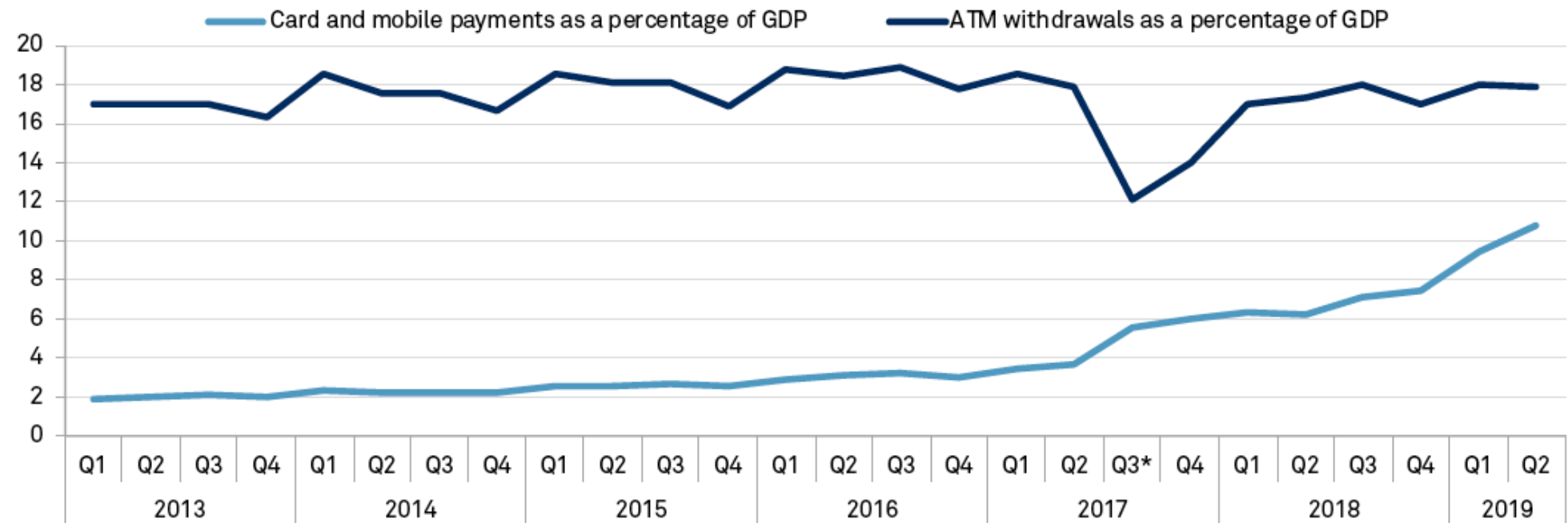
- China has 1.2 Billion vs. US's 110 million mobile wallets
- India counts around 450 million e-wallet users shared between companies like Paytm, Freecharge, Mobikwik, Airtel Money
- Singapore has 25% of its 5 million population using digital wallets, e.g. PayNow (launched 2017) has over 1.6 million users, 9 participating banks.
- South Korea has 40 million mobile wallet users, with 20 million fiat wallet users ; 10 trillion KRW exchanged through mobile money transactions
  - ◆ Kakao Pay is from one of S.Korea's largest chat apps (220 million users) ; with 20 million active users of its digital wallet.
  - ◆ Naver Pay with 4.5 monthly active users ; fee structures capped at 0.8% per transaction.
  - ◆ Recent unicorn Toss has 10 million users
- Thailand has its 40-million-user PromptPay (launched by Bank of Thailand)
  - ◆ Use same tech as Singapore's Paynow, allowing instant transfer using real-time payment switch from Vocalink technology ;
  - ◆ Line Pay, True Money and AirPay.
- Malaysia (20M), Myanmar (2M), Vietnam (10M), Indonesia (20M), Philippines (10M)
- Africa has 40 million mobile wallet users
- Russia has 100 million digital wallet users: Yandex Money (40M+ users)

Source: <https://medium.com/mobiletopup/digital-cash-is-here-say-goodbye-to-your-wallet-ec57b2c48058>



## Card, mobile payments rising even as ATM withdrawals returned to pre-demonetization levels (%)

Periods represent fiscal quarters



Data compiled Feb. 4, 2019.

\* On Nov. 8, 2016, the Indian government announced the demonetization of all 500 rupee and 1,000 rupee bank notes. The Indian fiscal year ends March 31, so the demonetization occurred during the third fiscal quarter of 2017.

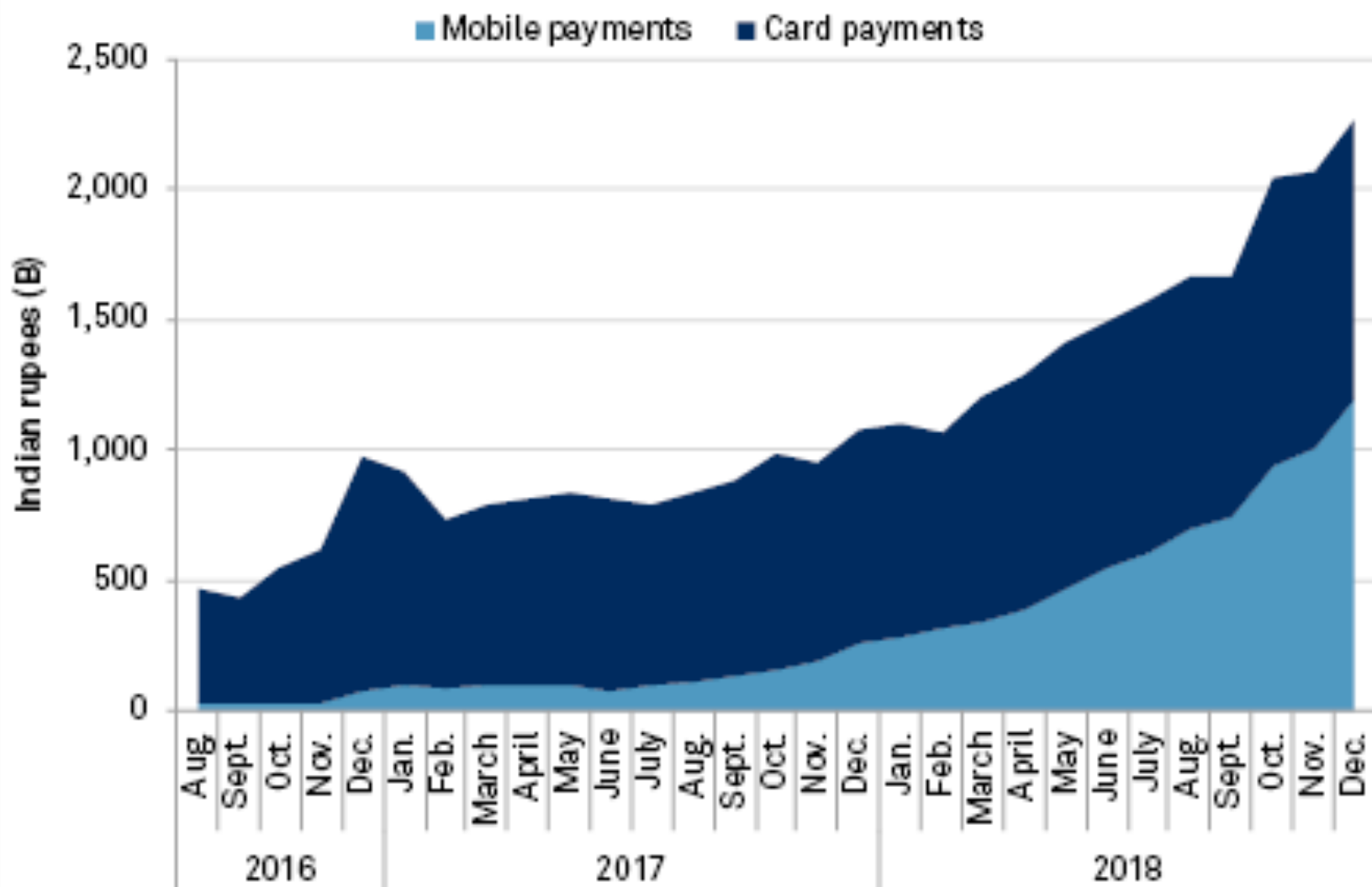
Card payments represent point-of-sale transactions completed using debit and credit cards, and include online transactions.

Mobile payments represent transactions processed through stored-value wallets and UPI.

Sources: S&P Global Market Intelligence, Reserve Bank of India, National Payments Corp. of India

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## Mobile payments growing faster than cards



Data compiled Feb. 12, 2019.

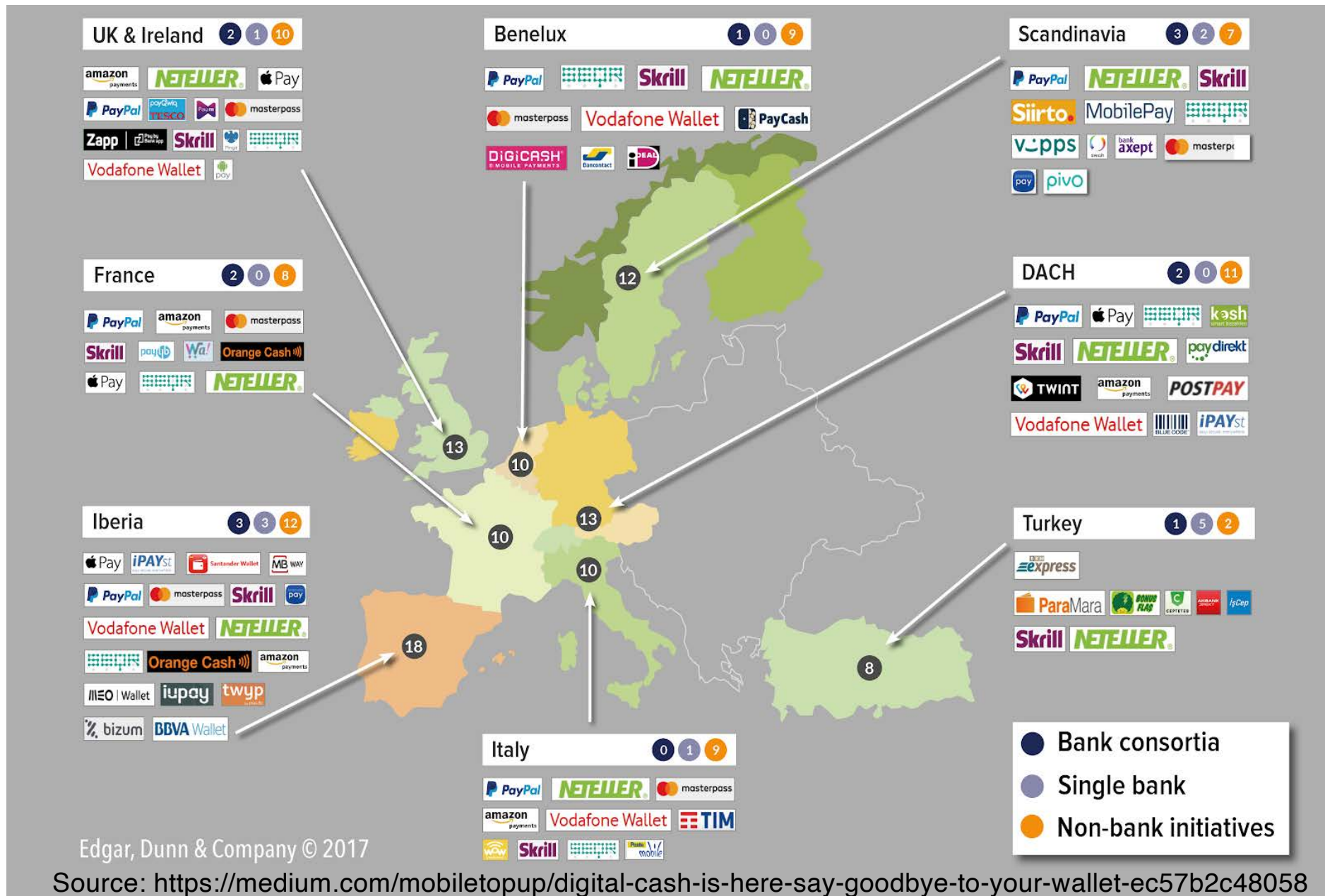
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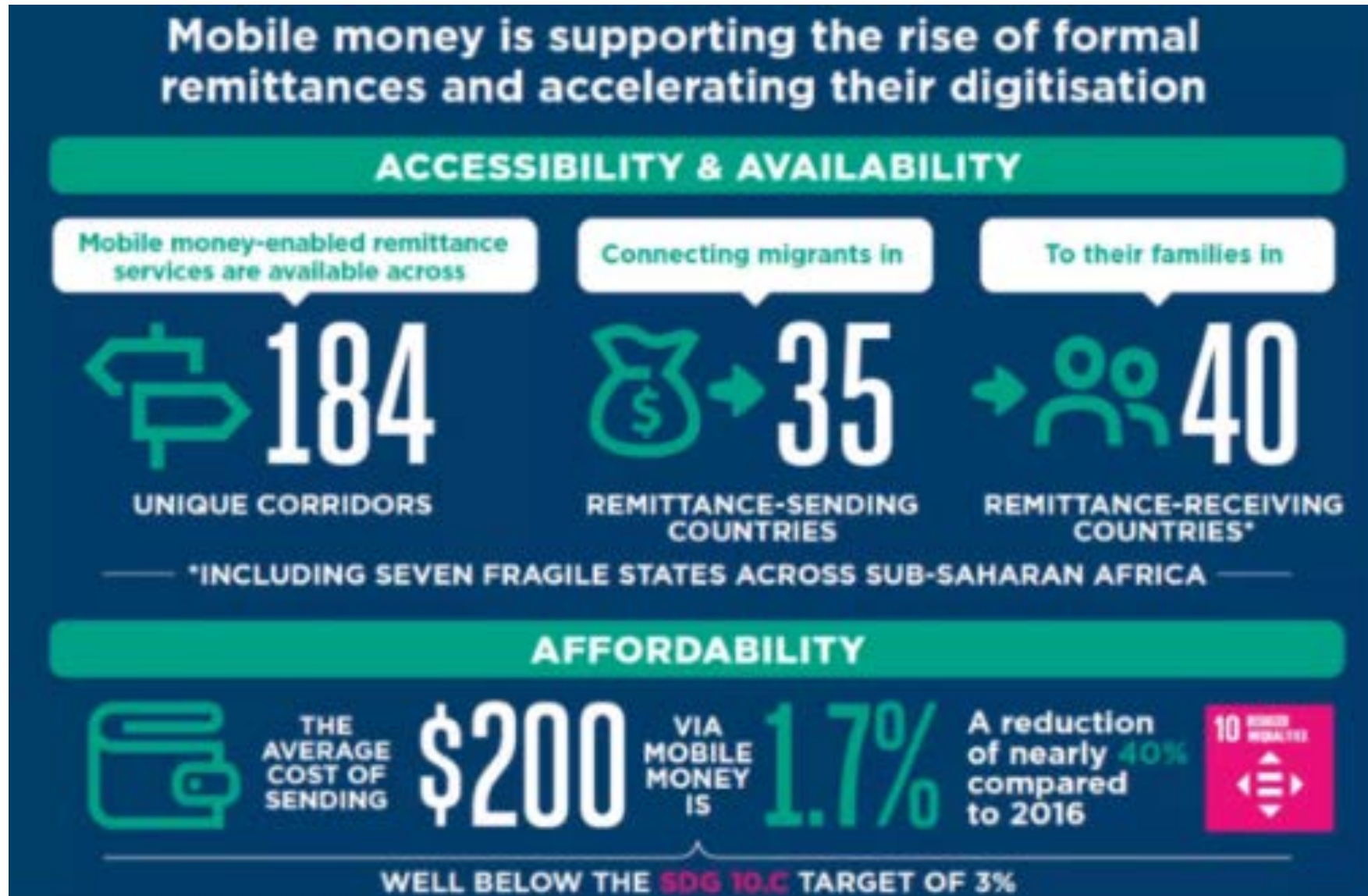
Sources: S&P Global Market Intelligence; Reserve Bank of India; National Payments Corp. of India

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# European Digital Wallet Landscape (circa 2017)

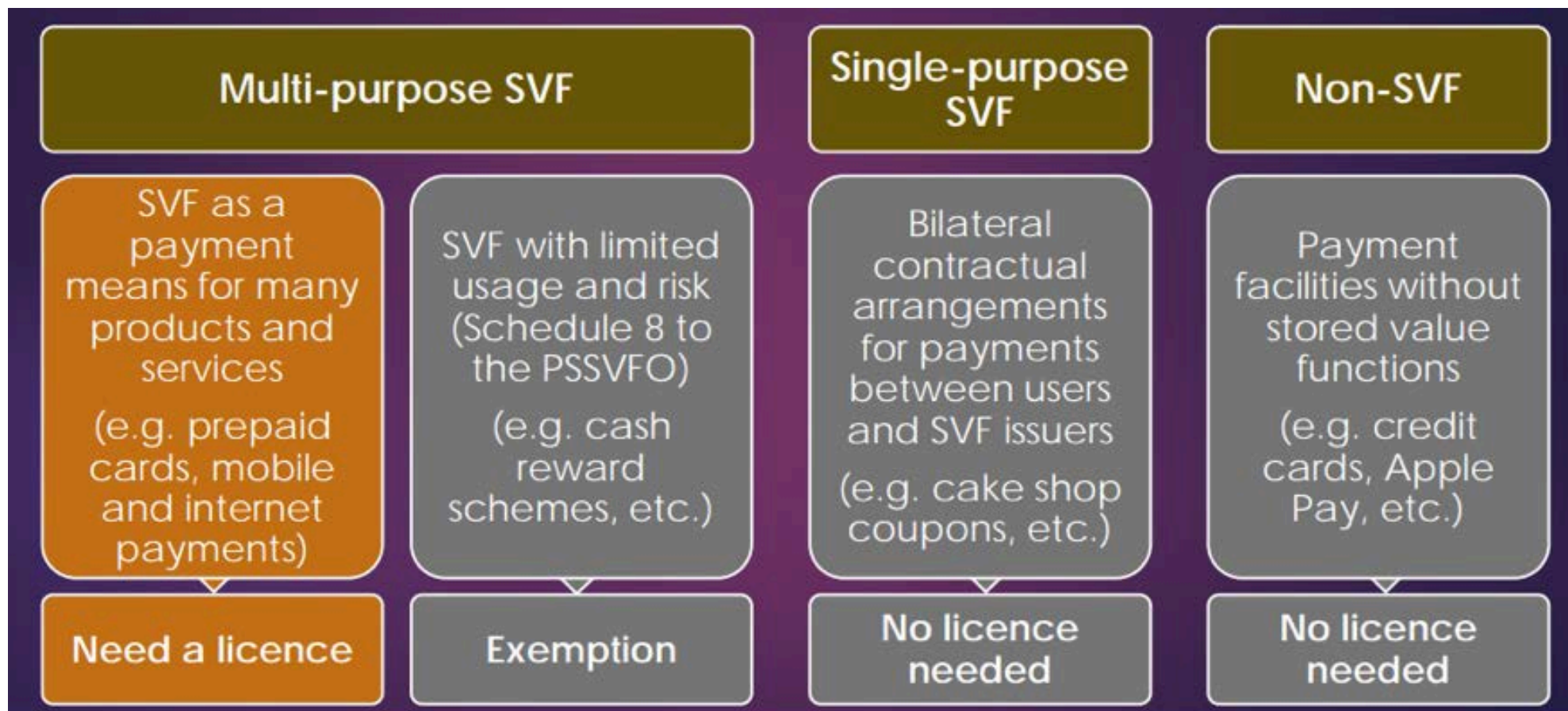


# Reduction of Cross Border Remittance with Mobile/ Digital Wallets



# Hong Kong Digital Payment Landscape

## Regulatory Framework: Licensing Requirements for SVF in Hong Kong



Source: Hong Kong Monetary Authority

# Hong Kong Digital Payment Landscape (cont'd)



Source: Startup Beat

Source: Fintech News Hong Kong, Sept 2016, <https://fintechnews.sg/5321/mobilepayments/first-5-licensed-players-in-hong-kong-digital-payment-landscape/>

# Mobile Payment's Impact on the Business of Conventional Banks

## Chinese vs. U.S. Payment Systems

Americans more typically involve banks and cards when paying with apps



### China

Paycheck is deposited into employee's bank account



Consumer transfers money into their wallet at Alibaba's **Alipay** or Tencent's **WeChat Pay** app in order to...

Shop online at many Chinese e-tailers

Shop at brick & mortar stores

Send money to friends or family

Transfer money abroad or make purchases on vacation



### U.S.

Paycheck is deposited into employee's bank account



Consumer uses **debit card** to shop, or...

→ Consumer uses bank account, debit or credit card to fund their wallet at **PayPal**, **Apple**, **Google**, **Samsung**, etc. in order to...

Consumer uses **credit card** to shop, or...

→

Send money to peers with **Zelle**

Pay friends or family with **Venmo**

Shop online at stores accepting wallet

Shop at brick & mortar stores accepting wallet

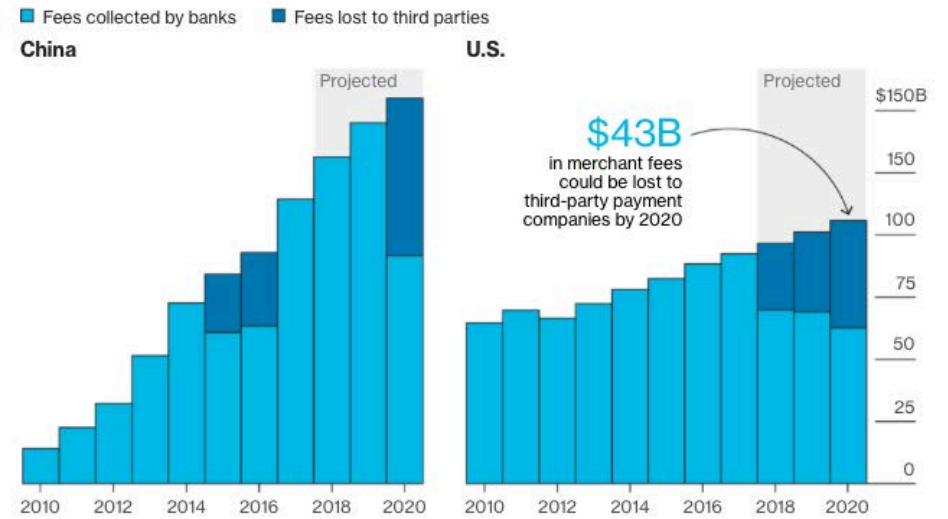
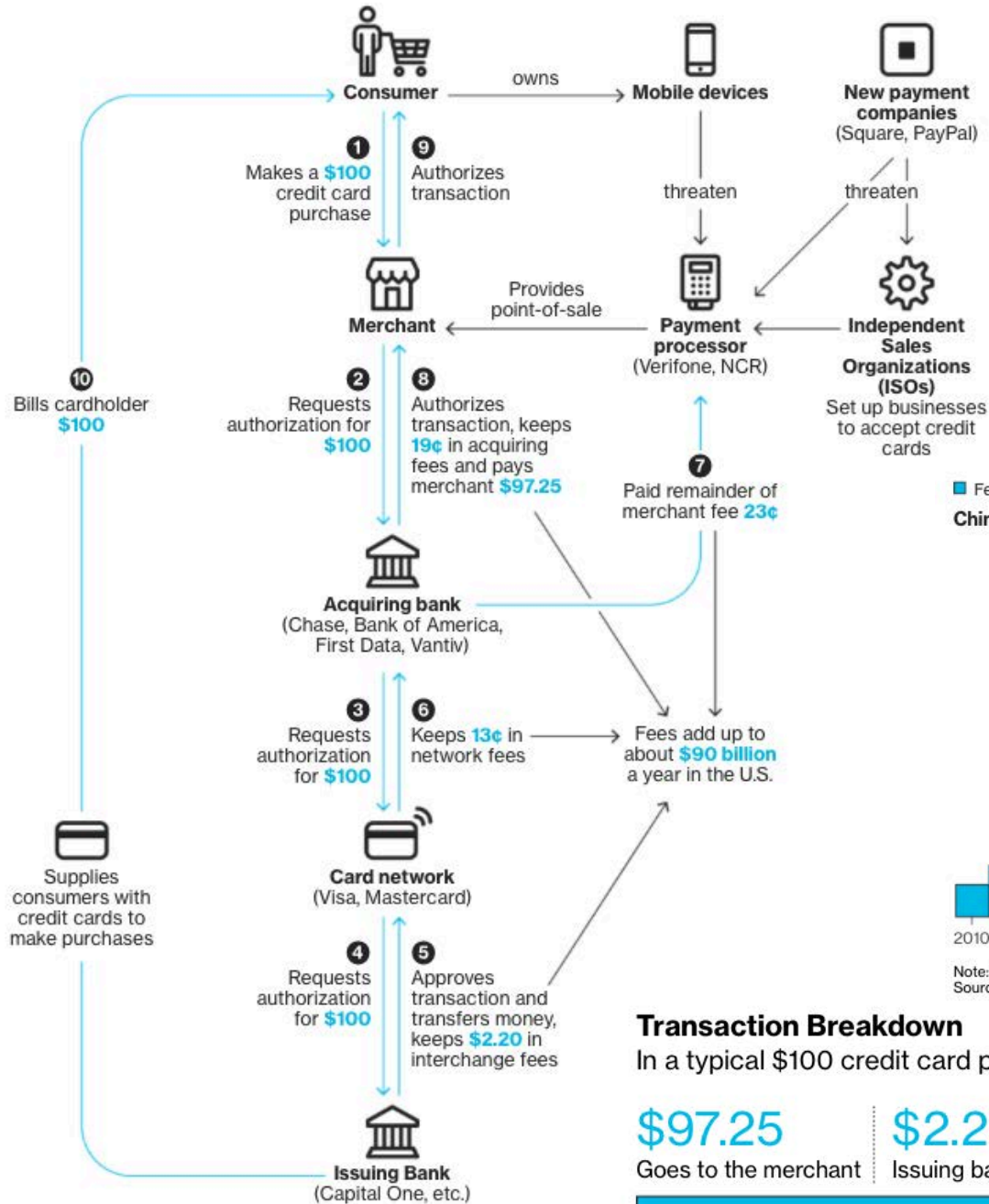
Some retailers like **Starbucks** have their own wallet

Source : "Why China's Payment apps gave US Bankers nightmares," Bloomberg Report, May 2018.  
<https://www.bloomberg.com/graphics/2018-payment-systems-china-usa/>



# How That \$100 Credit Card Purchase Is Processed

Established players face potential disruption



Note: No estimates are available for Chinese third-party fees for 2017-2019  
Sources: Kapronasia, Nilson Report

## Transaction Breakdown

In a typical \$100 credit card purchase...



## Easy Money

Checking accounts generate about \$3 billion in bank fees, which would dwindle if consumers embrace apps

**\$1.8B** in overdraft fees



**\$783.3M** in maintenance fees



**\$341.4M** in ATM fees

## Deposits

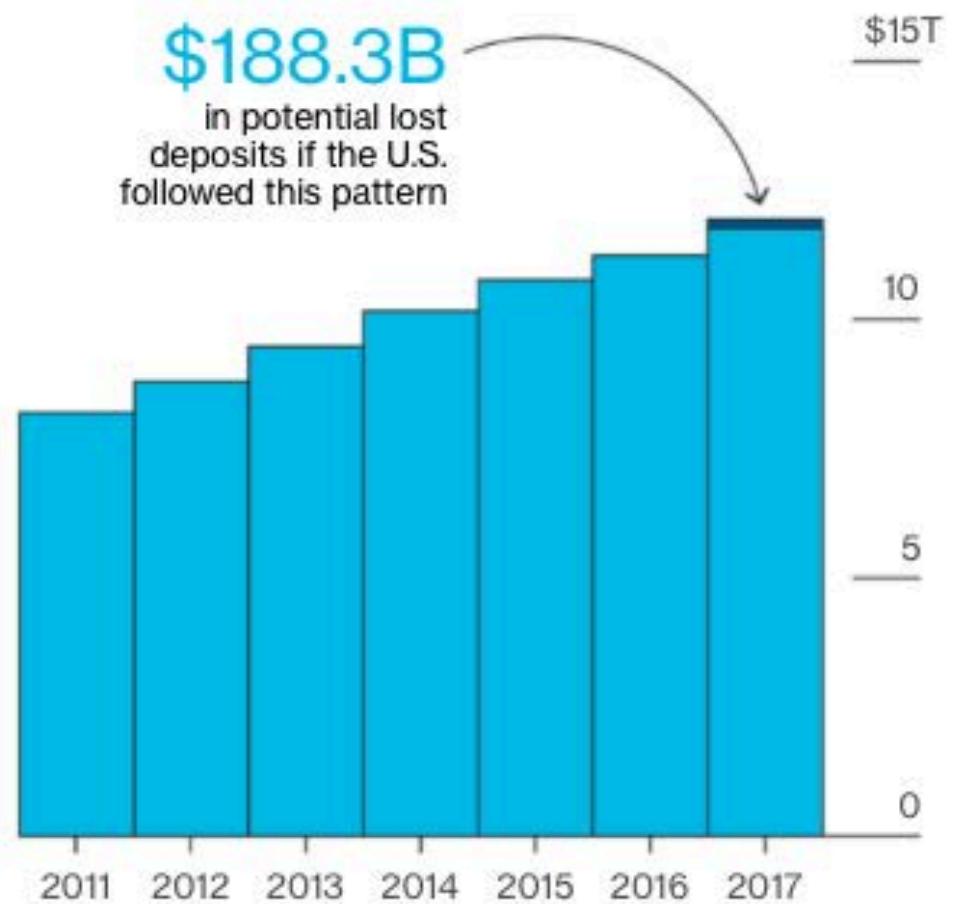
Even a relatively small bite to deposits would be a lot of money

■ Deposits collected by banks ■ Deposits lost to third parties

China



U.S.



Related Story:

<https://www.bloomberg.com/opinion/articles/2019-03-10/pboc-s-move-to-control-alipay-wechat-pay-deposits-is-power-grab>

Sources: Bloomberg Intelligence, Kapronasia

Source : "Why China's Payment Apps gave US Bankers Nightmares" , Bloomberg, May 2018

<https://www.bloomberg.com/graphics/2018-payment-systems-china-usa/>

# Major Ideas

- Tussles among different participants in a Mobile Payment Ecosystem / Value Chain
  - ◆ Alternative system architecture has great implications on business model and controlling rights !
- Liberation of Mobile Payment Realization from SEIs/ TSM via NFC-based Payment Card Emulation
  - ◆ The so-called NFC-based mobile payment goes far beyond yet another options for payment media/ communication technologies
  - ◆ Key is to enable a mobile device to emulate one or more Contactless Payment Cards, i.e. to become a Mobile Digital Wallet
    - ✦ Secure-Element (SE)-based vs. Host-based Card Emulation (HCE)
    - ✦ Implementation options of HCE: eSE vs. TEE vs. Cloud-based
- Tokenization to further enhance Payment Card Emulation security
- QR Codes as yet-another Payment Medium beyond wireless/ NFC
- Security Considerations for Mobile Payment Terminals at POS
- The Rise of Mobile payments in China:
  - ◆ Growth, User-bases & Services offered by Alipay vs. WeChat Pay vs. UnionPay
- The Rise of Mobile Digital Wallets Worldwide
- Impact on the business of Conventional Banks