Mo(bile) Money, Mo(bile) Problems: Security Analysis of Branchless Banking Apps in the Developing World

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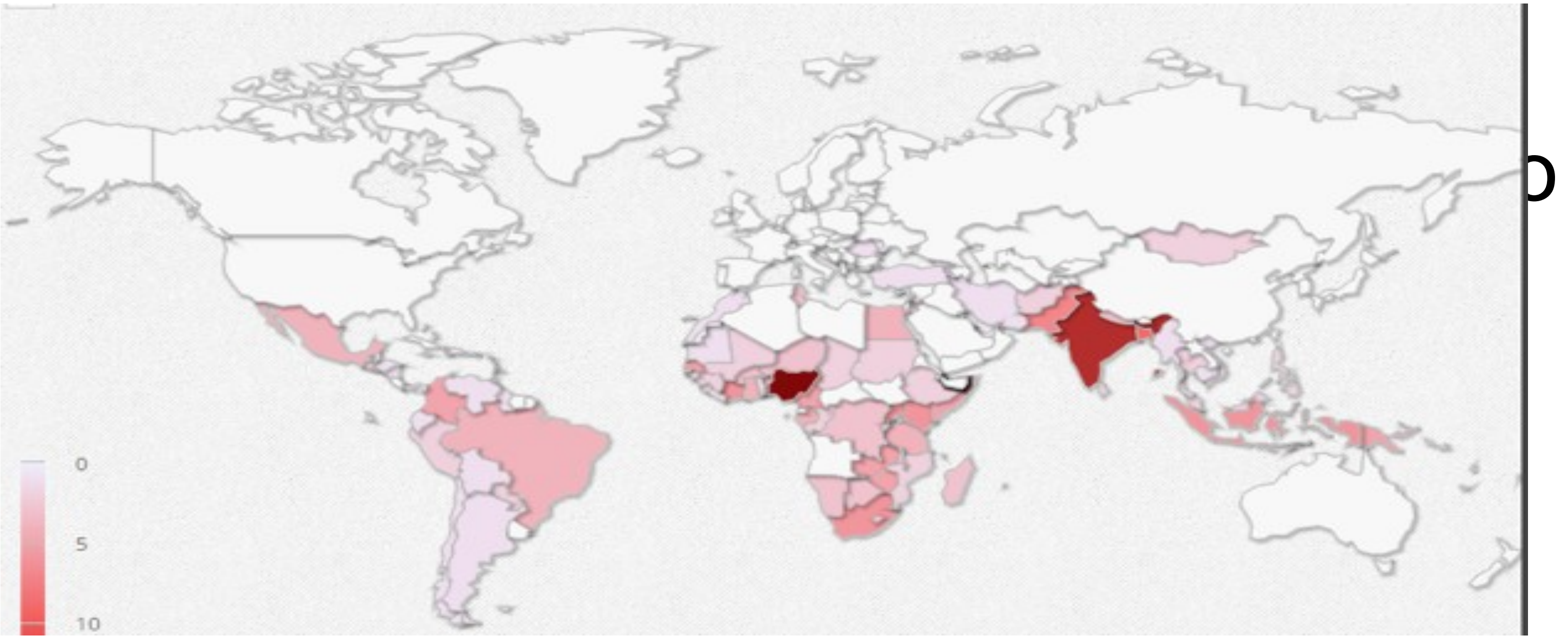
Branchless Banking a.k.a Mobile Money

- Generally deployed by companies outside of the traditional financial services sector
- Their use does not require having a previously established relationship with a bank
- They don’t rely on Internet connectivity exclusively, but also use SMS, Unstructured Supplementary Service Data or cellular voice to conduct transactions

Why this is important



- The security of mobile money has not been publicly investigated or verified

Analysis of mobile money apps

- We did an automated analysis of 46 currently available mobile money apps

- We did a manual analysis of 7 popular apps

Automated Analysis

- We used the Mallodroid tool to analyze the TLS implementation of 46 mobile money apps for Android
- Over 50% of apps had a SSL/TLS vulnerability

Manual Analysis: Apps

GCash	Phillipines
Zuum	Brazil
MCoin	Indonesia
Money on Mobile	India
Mpay	Thailand
Airtel Money	India
Oxigen Wallet	India

About 1.2 million users

Manual analysis

- Phase 1: Inspection
- Phase 2: Reverse engineering
- Security analysis of
  - Registration and login
  - User authentication after login
  - Money transfer

Findings: High level

- 6 out of 7 apps had easily-exploited critical vulnerabilities
- 28 Vulnerabilities in 6 of 7 analyzed apps
- 13 CWE categories
  - SSL/TLS & Certificate verification
  - Non-standard cryptography
  - Access control
  - Information leakage

Vulnerabilities by App

GCash	7
Money on Mobile	6
Oxigen Wallet	6
Mpay	4
MCoin	3
Airtel Money	2
Zuum	0

Vulnerabilities by type

Error Type	Number of Apps Vulnerable	Number of Vulnerabilities
TLS Certificate Verification	4	4
Non-standard Cryptography	4	6
Access Control	4	7
Information Leakage	5	12

TLS: Client side

- Some apps overrode Android’s default certificate verification routines

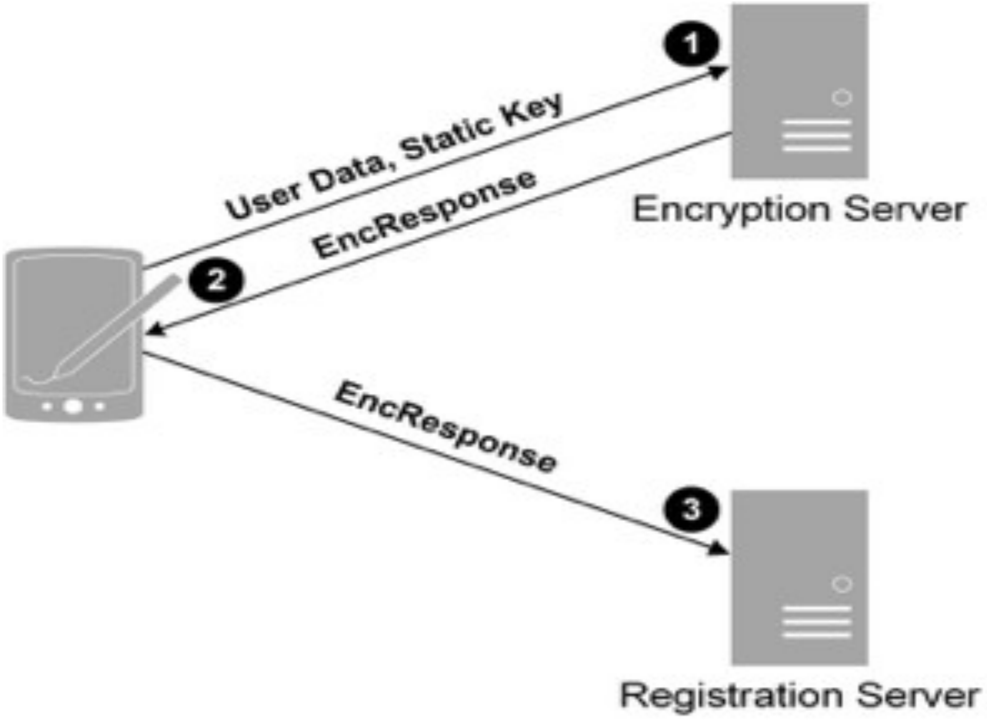
- Developers likely did this to silence certificate warnings during development or deployment

- mCoin disabled validation routines for the application to function correctly
  - The server side provides a certificate issued to “localhost” which is expired and self-signed

TLS: Server side

App	Qualys Score	Noteworthy Vulnerability
GCash	**C**	Vulnerable to POODLE attack
Money on Mobile	**N/A**	No TLS
Oxigen Wallet	**F**	SSL 2 support, MD5 cipher suite
Mpay	**F**	SSL 2, Client-initiated renegotiation, POODLE Attack
MCoin	**N/A**	Expired, self-signed certificate for localhost
Airtel Money	**A-**	Uses SHA-1 with RSA
Zuum	**A-**	Uses SHA-1 with RSA

DIY cryptography: MoneyOnMobile



All messages are sent over plaintext HTTP.

DIY cryptography: Airtel

$$Key_{enc} = \texttt{j7zgy1yv} \,\|\, phone\# \,\|\, account\#$$

- This key is used to encrypt the user PIN, used to authenticate with the service
- All of these fields are available in previous messages “protected” by broken TLS
- Because TLS certificate validation is effectively disabled, we can get this account

Access control

- Oxigen Wallet allows password reset with an unauthenticated SMS sent from a user’s phone
- MoneyOnMobile only checked the PIN to move between screens in the app
- mPay accepts and performs unauthenticated commands from its server
- …

Information leakage

- Logging
  - mPay logs include user credentials, personal identifiers, and card numbers
  - MoneyOnMobile logs include server responses and account balances

- Preference storage
  - GCash stores the users’ PIN in the preference
  - mCoin stores the user’s name, birthday, and certain financial infromation.

Terms of Service

- User is responsible for all authenticated transactions
  - When these systems are attacked, the user pays the price

Conclusion

- Mobile money applications improve the standard of living for many in the developing world
- However, significant vulnerabilities are identified in mobile money applications
- Dramatic improvements to the security of mobile money applications are needed to protect these systems

Discussion

- What’s the contribution of this paper?
- Anyone has experience with mobile money? Is there any security flaw in the mobile money model?
- What’s the reasons for the vulnerabilities in the apps?
- Does regulations help improve finance security?
- How to improve the security of mobile money systems?