Computing and Financial Services for the Poor: The UW Digital Financial Services Research Group

Richard Anderson
University of Washington
Seattle, USA
Pathway out of poverty

• How can the lives of the billions of people who live on a few dollars a day be improved

• Multiple factors
  – Health, governance, education, poverty, food security, environment, infrastructure, civil strife
Improved financial services help

• Strong evidence that improving access to financial services can help people stay out of poverty
  – Poor pay more for services
  – Create new livelihood opportunities
  – Allow more efficient delivery of other services
  – Savings provide a buffer against financial shocks
Technology opportunities for Digital Financial Services

• Near universal access to mobile phones provide an interface with a financial system

• Mobile carriers, financial institutions, and government entities can lower the cost of financial services

• Address central financial needs
Financial services for the poor

• Expand accesses to financial services
Basic Financial Services

• Mobile Money
  – Send money to remote location
  – No bank accounts, but mobile phones
  – Rely on basic mobile phones
Background: M-Pesa in Kenya

- Considered most successful mobile money product
- Implemented by Safaricom (Kenya’s dominant mobile carrier)
- Large CICO (cash in, cash out) agent network
- Works on basic mobile phone through USSD/Sim App
- Send money to a mobile number – various messages and pins to withdraw money from an agent and issue a receipt
However . . . the challenges

• Inconsistent uptake of services
  – No other country has matched Kenya in adoption of mobile money

• Obstacles at consumer level
  – Usability, trust, understanding of services

• Obstacles at implementation level
  – Security, detecting fraud, know your customer, infrastructure failure, managing agents

• Obstacles at system level
  – Multiple carriers, regulatory regime
Financial services for the poor

- Improved access to financial services is recognized as an important mechanism for raising people out of poverty.

- Financial Services for the Poor
  - Remittances
  - Savings accounts
  - Government payments
  - Digital payments
  - Insurance
Our hypothesis

• Computer scientists, in *partnership* with others, can address *some* of these challenges

• Many organizations have been working in mobile money and publishing studies
  – GSMA, CGAP

• Economists and political scientists are studying impact

• Work needs to tie into mobile operators, financial institutions, and government organizations
The research project

• Faculty
  – Richard Anderson, Kurtis Heimerl, Franzi Roesner, Yoshi Kohno

• Researchers
  – Shrirang Mare, Jake Kendall

• Graduate Students
  – Fahad Pervaiz, Samia Ibtasam, Trevor Perrier, Sam Castle, Kushal Shah, Aditya Vashistha

• Project launched January, 2016
DFS Challenges

1. Fraud
2. Cyberattacks
3. Proximity payments user experience
4. Identity and on-boarding
5. Analytics for product development, risk scoring, and fraud detection
6. Cash-in/Cash-out (CICO) agent recruitment, training, and management
7. Financial management for end users
8. Reach and robustness of infrastructure
Research approach

• Judicious landscaping to identify research areas
• Launch a set of small projects
  – USSD
  – Security
  – Computer Science / DFS survey
• Identify area for larger scale implementation
  – Prototype toolkit
  – Work with Financial partners for in country evaluation
  – Refine and handoff to partners
• Establish partnerships for field based work
• UW-Pesa demonstration lab
Basic assumption and focus

- Must focus on reach of financial services to the poor
- Must align with government programs, financial institutions and mobile operators
- Need to work with innovative partners and fintechs
- Technologies
  - Must allow basic phone for clients
  - Can assume better technology for agents (e.g., Android phone)
  - Robust to infrastructure failure
Research challenges / Security

• Security of mobile money
  – GSM level security
    • USSD or SIM Apps
  – Android app security
  – Usability and resilience to poor infrastructure are key

• Fraud
  – Risks of fraud across the entire process
    • Many potential bad actors
  – Restrict attention to issues directly related to digital financial services and specific products
  – Lack of data on occurrences of fraud
Research challenges / Usability

• Client side
  – Simplification of process
    • Complexity arises due to security and weak infrastructure
  – Increasing transparency
  – Lack of trust is a deterrence to adoption
    • E.g., worries about sending money to wrong number, or loss of money from account
  – Need data on problems that occur in practice on specific systems

• Proximity payments
  – Point of sale device
  – Identity
  – Simplified biometrics
  – Hardware support and android devices
Research Challenges/Use of data

- Credit scoring
  - Use of data on phone usage to determine likelihood of default
- Fraud detection
  - Transaction records to detect potentially fraudulent use
  - Analysis to identify patterns of fraud (existence of fraud)
- Call records data to understand potential services
- Initial work
  - Landscape data sources and match to application areas
Research Challenges/Consumer education

• Promotion of good financial practices
• Understanding of basic financial instruments
• How to use of financial services
• Promotion of financial services

• Application of ICT/Behavior change
  – Messaging
  – Community Led Video Education
Research Challenge / Integration

- Integration of mobile money into broader services
  - Payment for services (e.g., school fees)
  - Consumer subsidies
- Community networks
  - Local cellular
Project stages

**Formative (1-9 months)**
- To identify and assess problems of interest
- Review literature
- Identify problems of interest
- Assess technologies to address identified problems
- Develop proof of concept solutions

**Development (6-18 months)**
- To build prototype solutions and evaluate them in controlled settings
- Validate choice of technology
- Develop robust prototype
- Evaluate prototypes in controlled settings and iterate development based on findings
- Document findings for publication

**Translation (12-24 months)**
- To scale prototype for deployment and transfer technology to partners
- Refine prototype solution to production quality to be ready for third party deployment
- Work with partners to identify settings to deploy the solution
- Develop documentation and support tools to share with partners
- Transfer technology to partners
Projects overview

Mobile app security
Fraud in DFS
Proximity payments
Data analytics
Android devices for DFS
DFS Video Education
UW-Pesa Demo Lab
PROJECT 1: MOBILE APP SECURITY
App Security Overview

Goal: Understand vulnerabilities in mobile money deployments

1. Design of Threat Model Particular to Mobile Money
2. General Security Analysis
   – 197 decompiled Android apps
   – Automated detection of permission requests, version requirements, external libraries, and HTTPS URL usage
3. In-depth Analysis
   – 71 apps, including Android and USSD-based
   – Manual assessment of relevant properties, including KYC requirements, password reset procedures, SMS usage
4. Developer Interviews
   – No of Developers: 7
   – Average Interview duration: 45 min
   – Questions: Experience, Org Structure, Training and Security Processes
Android apps contain numerous HTTP URLs
... and known tracking libraries

- google-analytics.com
- doubleclick.net
- gstatic.com
- crashlytics.com
- fabric.io
- media.admob.com
- phonegap.com
- tools.ietf
- appsflyer.com
- flurry.com
- hockeyapp.net
Developer Interviews

- **Goal**: Understand the source of vulnerabilities
- Contacted 249 email addresses
- **Location**: Nigeria, Kenya (2), Uganda, Zimbabwe, Colombia (2)
- **Organizations**: Bank (2), Telco (3), Software Company (2)
- Mostly large organizations
Findings

• Security Analysis
  – Android system updates have resolved many issues, but apps have outdated version requirements
  – SSL/TLS, if implemented, is often incorrect

• Interviews
  – Vulnerabilities may arise through specifications from various stakeholders
  – Security qualifications are not standardized at national or market levels
  – Inadequate domain-relevant resources lead many developers to unvetted online forums
Future Directions

• **Resources for Best Practices**
  – Document domain-specific security practices

• **Developer Self-Assessment Tools**
  – Build tools to provide relevant feedback on potential vulnerabilities in Android and USSD apps
  – Leverage prior research on automated Android analysis
  – Combine manual developer analysis for nuanced issues, such as PIN recovery
PROJECT 2: FRAUD IN DFS
SMS-driven Fraud

- 7.6 billion mobile connections
- 4.7 billion unique subscribers

- Transactions SMS
- Payments and dues
- One-time pins
- Account recovery SMS

Research Questions
- What types of fraud are occurring over SMS
- What are System-level indicators to detect fraud
- Different telco and user level fraud detection methods
- Fraud detection in Android vs. feature phones
Preliminary Findings

• We collected 106 SMS Examples

• Major categories: promotions, receipts, and loan offers

• Strongest indicators of fraud are URLs and phone numbers in SMS.
Next steps

• A user study to collect a larger data corpus
• Understand the nature and extent of SMS-driven fraud in DFS
• Understand people’s ability to detect phishing SMS
• Develop and deploy SMS-fraud detection and mitigation tools
Focus: Point of Sale

• Current methods are slow (60-90 seconds) and error prone, and vulnerable to fraud.

• Ongoing work:
  – Documenting proximity payment protocols at PoS in different countries.
Next steps

• Conduct usability and security evaluation of these protocols

• Develop usable and secure proximity payment methods for feature phones
  – We are exploring NFC and sound-based methods
PROJECT 4: DATA ANALYTICS
Challenges

• Accessibility of datasets
• Combining different datasets for more rich information
• With the datasets we have, can we answer interesting questions related to agent churn, business evolution over time, liquidity management, and so forth
Agents survey data

1. General Information
   - Surveyor Information, Location of the agent etc.
2. Demographic information about the agent
3. Agent’s business profile
   - Status of the business
   - Information about the providers served by the agent
4. Customers and business information
   - Repeating customers, average number of transactions per provider
5. Liquidity and Float Management
6. Revenue and Commission Structure
7. Service downtime
8. Agent Training
9. Monitoring and support services provided by the operator
10. Marketing by the DFS provider
11. Risk and Fraud Issues
12. DFS Challenges
Helix Agent Survey

Country Profile

2013: Kenya, Tanzania, Uganda
2014: Kenya, Pakistan, Bangladesh, India
2015: Senegal

Number of agents surveyed
Locations of agents surveyed in Kenya in 2013 and 2014

Red dots: surveyed in 2013
Blue dots: surveyed in 2014
Ongoing work

• Cleaning the dataset
• Making data accessible: developing an interactive portal to query and visualize the data
• Next steps:
  – Merging Helix dataset with Financial Inclusion Insights dataset (customer survey dataset)
  – Deep dive in data analysis
PROJECT 5: ANDROID DEVICES FOR DFS
Android devices in DFS ecosystem

• Many proposals for using Android mobile phones for Digital Financial Services
  – Financial applications
  – Point of sale devices
  – Biometric

• Question: Are all Android phones the same?
Research program

- Develop use case catalog
- Identify hardware requirements of different DFS applications
- Look at tear downs of different classes of Android phones
  - $50 phone
  - $100 phone
  - $400 phone
PROJECT 6: COMMUNITY LED VIDEO EDUCATION FOR DFS
Projecting Health

Community led video education for basic health practices
Community Led Video Education for Financial Education

- People in rural areas lack understanding of digital financial services
- Community Led Video Education has been successful for promoting health and agriculture practices
  - Does it have the same applicability for financial services?
Rajasthan Pilot Study

• Project in planning stage for Pali District of Rajasthan
  – Community created videos on topics such as how to use a mobile payments app
  – Show videos in community groups
• Six month pilot project with Government support
DFS Demo Lab

PROJECT 7: UW-PESA DEMONSTRATION LAB
Architecture

![Diagram of UW-Pesa v0.1 architecture](image)

- Supports
- Actors
- Transactions

**UW-Pesa v0.1**

- Django Server
  - Dashboard
  - POS
  - API
  - USSD interface
  - Web interface
  - Android App
What is UW-Pesa Demo Lab?

• A test bed to experiment with various DFS technologies and security protocols

• A test bed to conduct usability studies, rapidly prototype product design, and test solutions.

• A community building and education tool.

• An outreach tool.
USSD interface for UW-Pesa

• Getting a working USSD for research projects is challenging.

• We developed a USSD simulator, and implemented it using a USSD gateway from Africa’s Talking.

• Result: A working USSD interface for UW-Pesa.
Ongoing work and next steps

• Develop web and mobile app interfaces for USSD

• Implement mobile money services protocols similar to existing services such as M-Pesa and EasyPaisa.

• Integrate PoS and KYC using biometrics.
DFS Research group

- Richard Anderson
- Kurtis Heimerl
- Franzi Roesner
- Yoshi Kohno
- Ruth Anderson
- Jake Kendall
- Shrirang Mare
- Kevin Johnson
- Sam Castle
- Samia Ibtasam
- Trevor Perrier
- Fahad Pervaiz
- Kushal Shah
- Aditya Vashistha
- Arjun Lalwani
- Emily Leland
- Koevering Van Katherine
- Sarah Yu
Collaborators

DFS LAB

MicroSave
Market-led solutions for financial services

EVANS SCHOOL OF PUBLIC POLICY & GOVERNANCE
UNIVERSITY of WASHINGTON
Evans School Policy Analysis and Research (EPAR)

HELIx
INSTITUTE OF DIGITAL FINANCE

BILL & MELINDA GATES FOUNDATION
Computing and Financial Services for the Poor: The UW Digital Financial Services Research Group

Richard Anderson
anderson@cs.washington.edu

For more information visit: dfs.cs.washington.edu