The UW Digital Financial Services Research Group: An Update

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Research in Digital Financial Services

Improved access to financial services is critical for raising people out of poverty

- Technological challenges impede the introduction and adoption of financial services
- Computer Scientists and Information and Computing for Development (ICTD) researchers can help address these challenges
Financial Services

• Basic financial services
  – Remittances
  – Savings
  – Government payments
  – Digital payments
  – Insurance
  – Bank accounts

• Mobile money
  – Financial products linked to mobile operators
  – Commonly including Cash In, Cash Out (CICO) agents
Financial Services Landscape

• Mobile phones provide access to digital economy
  – Smart phones and basic phones

• Mobile operators and banks are both important
  – Variation across countries
  – Regulations have a big impact

• Government priority in many countries
  – Reducing role of cash
  – Link to national ID

• Fintechs have a role for innovation and market disruption
Challenges

- Inconsistent uptake of services
- Obstacles at consumer level
  - Usability, trust, understanding of services
- Obstacles at implementation level
  - Security, detecting fraud, proving and verifying identity, infrastructure failure, managing agents
- Obstacles at system level
  - Multiple carriers, regulatory regime, costs, market understanding
Digital Financial Services 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. End user education
8. Reach and robustness of infrastructure
UW DFS Research Group

• Develop and deploy technological solutions to specific challenges that impede the introduction and wide scale deployment of DFS

• Build a global academic community focused on computing and DFS technologies
Research Group

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

• Researchers
  – Shrirang Mare, Jake Kendall

• Students
  – Fahad Pervaiz, Samia Ibtasam, Trevor Perrier, Sam Castle, Kushal Shah, Aditya Vashistha, Matt Johnson, Esther Jang, Galen Weld, Arjun Lalwani, Emily Leland, Katherine Van Koevering, Sarah Yu
What we are working on

• Research projects
• UW-Pesa Demonstration Lab
• Technology explorations
• Building a global research community
Research approach

• Judicious landscaping to identify research areas
• Launch small projects with single deliverable
• Successful projects extended to develop technologies
• Identify areas 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
Basic assumptions

• 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
  – Mobile phones are the primary consumer access point
    • Basic GSM phones
    • Expanding use of smart phones, especially, low cost Android phones
  – Can assume better technology for agents (e.g., Android phone)
  – Need to be robust to infrastructure failure
Formal project structure

**Project stage**

- **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

Change Seminar, March 28, 2017
Current projects overview

Mobile app security

Fraud in DFS

Proximity payments

Data analytics

Android devices for DFS

DFS Video Education
PROJECT 1: MOBILE APP SECURITY
## Security of Mobile Financial Applications

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Change Seminar, March 28, 2017
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
   – Number of Developers: 7
   – Average Interview duration: 45 min
   – Questions: Experience, Organizational Structure, Training and Security Processes
Software Developer Interviews

- Goal: Understand the source of vulnerabilities
- Contacted email addresses from App Store
- Location: Nigeria, Kenya (2), Uganda, Zimbabwe, Colombia (2)
- Organizations: Bank (2), Telco (3), Software Company (2)
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
Sample SMS Messages

- M PESA KJF31UCDTGV
  Confirmed. You have received ksh4,530 from COLLINS ONYANGO 0797708822 on 29/10/16. New M-PESA balance: ksh(LOCKED). Pay bills via Mpesa@.

- Welcome KCB Bank, LOTTO promotions! 2016 you’re the lucky winner of ksh 100,000.00 call on Mr Alex 0788197232. DON’T PAY ANYTHING, SENDER KCB.

- Dear safaricom Customer, KCB Mpesa soft loan now available at 5% interest @kshs 25,000/- 50,000/- 100,000/- call or sms 0780999000. OKOA MAISHA NA KCB.

- Dear safaricom Customer, KCB Mpesa soft loan now available at 5% interest @kshs 25,000/- 50,000/- 100,000/- call us or sms! 0780999000. OKOA MAISHA NA KCB.
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
PROJECT 3: PAYMENT EXPERIENCE
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
  – Exploring different technologies for customer/merchant communication
Focus: Mobile Application Use

• Rapid adoption of low-cost smart phones
• Challenge in usability of financial applications by new users
• Assessment work in Pakistan
  – Interviews on mobile money awareness and barriers
  – Task timing for use of applications
• Findings from initial work
  – Obvious usability fixes needed before deeper study
• Current investigation
  – Addressing learnability based on improved prototype
PROJECT 4: DATA ANALYTICS
Developing tools to support mobile money assessment

• Intervention assessment
  – Determine the need for product or technological intervention

• Impact assessment
  – Evaluate the impact of a technology or product
Example: Helix Agent Survey

Country Profile

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

Number of agents surveyed

- Bangladesh2014
- India2014
- Kenya2013
- Kenya2014
- KenyaPanel
- Pakistan2014
- Senegal2015
- Tanzania2013
- Tanzania2015
- Uganda2013
- Uganda2015
- Zambia2015

Number of Agents
Ongoing work

• Improving the data cleaning pipeline
  – Understand processing steps for improving “development data”
  – Example problem: Address look up – going from survey street addresses to geo-coordinates

• Combining data sets
  – Aligning multiple data sets for deeper analysis
  – Combining Helix Agent dataset with Financial Inclusion Insights dataset
  – Improved sub-national data modeling
PROJECT 5: UNDERSTANDING THE ANDROID ECOSYSTEM FOR DFS
Android devices for DFS

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

• What are the limitations of low cost Android phones?
Research program

• Develop use case catalog
• Identify hardware requirements of different DFS applications
• Create synthetic workloads for targeted use cases
• Look at tear downs of different classes of Android phones
  – $50 phone
  – $100 phone
  – $400 phone
• Project goals:
  – Identify the limitations of low cost Android phones
  – Develop an evaluation framework
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?
  - What are requirements for service awareness versus service use?
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
UW-PESA DEMONSTRATION LAB
UW-Pesa Demo Lab

• Implement a local mobile money system
  – Manage a set of accounts
  – Support basic mobile money transactions between users
  – Based on MTN mobile money product

• Initial target person to person/ person to agent transactions
  – Later will extend to broader set of devices including point of sale and biometrics.
Architecture

• Django server with interfaces to support multiple devices
  – Web interface
  – Android App Interface
  – USSD Interface

• Implementing on top of CommunityCellularManager for local deployment
Goals for UW-Pesa

• Demonstration site for mobile money technologies
  – Internal learnings
  – External education and outreach

• Testbed for experimentation
  – Usability testing
  – Integration testing
  – Workflow
Technology Dives

- USSD
- Sim Apps
- Thin Sims
- Interledger Protocol
- Block Chain
- Voice Biometrics
- Fingerprint recognition
- India stack
Unstructured Supplementary Service Data (USSD)

- Protocol in GSM for data exchange
  - Similar to SMS, but session based
  - Under control of mobile operators
  - Used to implement menu based applications, including mobile money

- Explored tools for implementing USSD applications and gateways to USSD services
Thin Sims

• SimApp: Application embedded on sim card

• Overlay Sim
  – Technology to allow an external application to run with sim card
  – Primary use: Make dumb phones smart

• Proposed for various mobile money systems

• Security issue: Man in the middle
India Stack

- Technology suite released by India to support electronic services
- Started with Unique ID (UIDAI) which became Aadhaar
- Additional components: payments gateway, document locker, document signing
- Focus on making APIs available so services can be built on top of the India Stack
Building the research field

• Promoting global work in Computing and DFS
  – Increase the number of researchers working in the area
  – Develop multiple centers of expertise

• Strategy
  – Developing background and literature surveys
  – Sessions at conferences
    • ICTD 2016 Open Session
  – Networking and community building
  – Planning FinTech workshop before ICTD 2017
  – Create replicable model for Computing and DFS research center
Fintech Center, ITU, Lahore

- Established a research center at Information Technology University, Lahore
- Director: Lubna Razaq
- Establishing projects to parallel existing UW Projects
  - User experience
  - Android Use Cases
  - Financial Education
Collaborators

EVANS SCHOOL OF PUBLIC POLICY & GOVERNANCE
UNIVERSITY of WASHINGTON
Evans School Policy Analysis and Research (EPAR)
Computing and Financial Services for the Poor: The UW Digital Financial Services Research Group

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