Computing and Digital Financial Services

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DIGITAL FINANCIAL SERVICES
RESEARCH GROUP

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 digital financial services (DFS)
- Computer Scientists and Information and Computing for Development (ICTD) researchers can help address these challenges

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

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

NADRA PAKISTAN

easypaisa

airtel MTN

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
  - Networking and community building
  - Planning FinTech workshop before ICTD 2017
  - Create replicable model for Computing and DFS research center

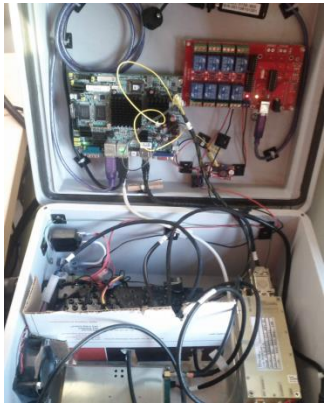
Fintech Center, ITU, Lahore

- 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

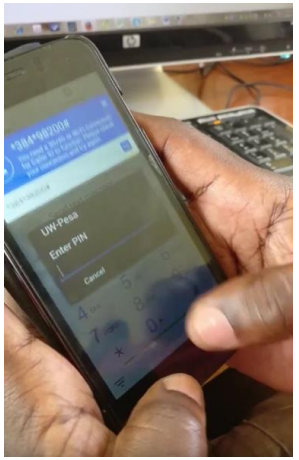
Challenges to expanding the reach of financial services to the poor

- 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

What we are working on



- Research projects
- UW-Pesa Demonstration Lab
- Technology explorations



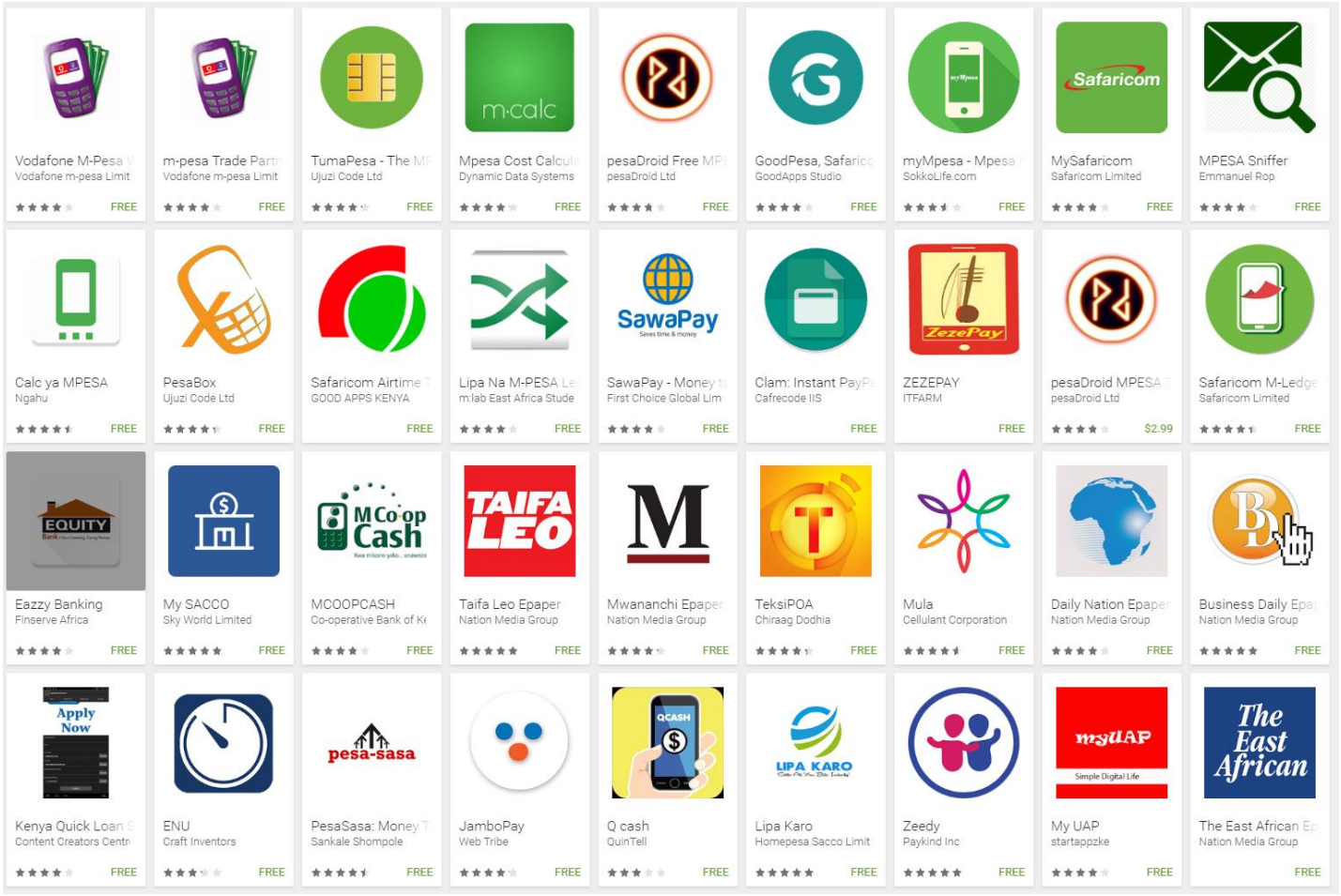
Research approach

- 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

Project Portfolio

PROJECT 1: MOBILE APP SECURITY

Security of Mobile Financial Applications



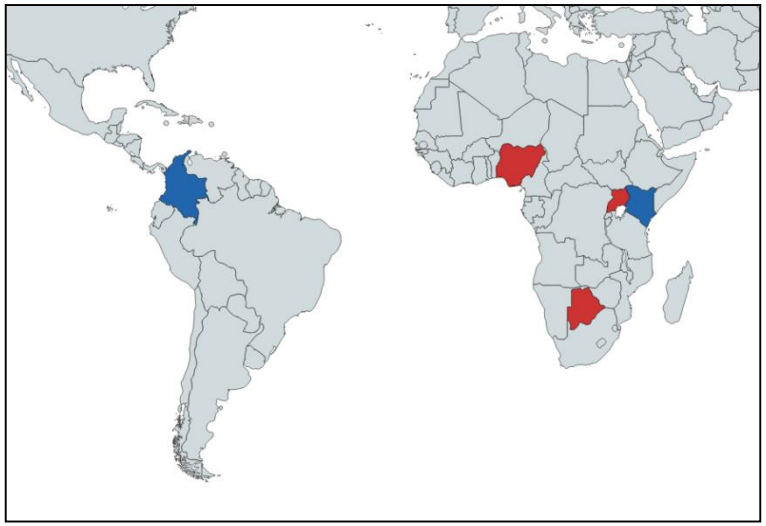
App Security Overview

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

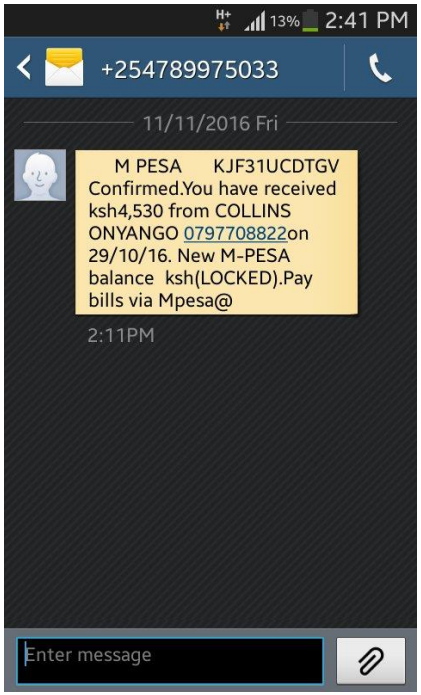
- Security Analysis
  - Android system updates have resolved many issues, but apps have outdated version requirements
  - SSL/TLS, if implemented, is often incorrect
- Interviews
  - Vulnerabilities may arise through specifications from various stakeholders
  - Security qualifications are not standardized at national or market levels
  - Inadequate domain-relevant resources lead many developers to unvetted online forums

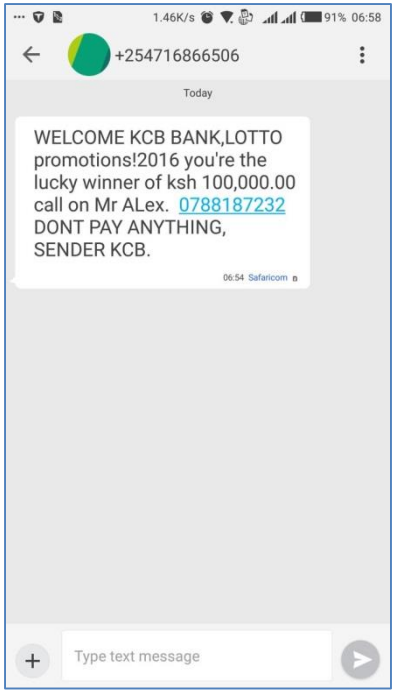
Future Directions

- 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





SMS-driven Fraud

- 7.6 billion mobile connections
- 4.7 billion unique subscribers

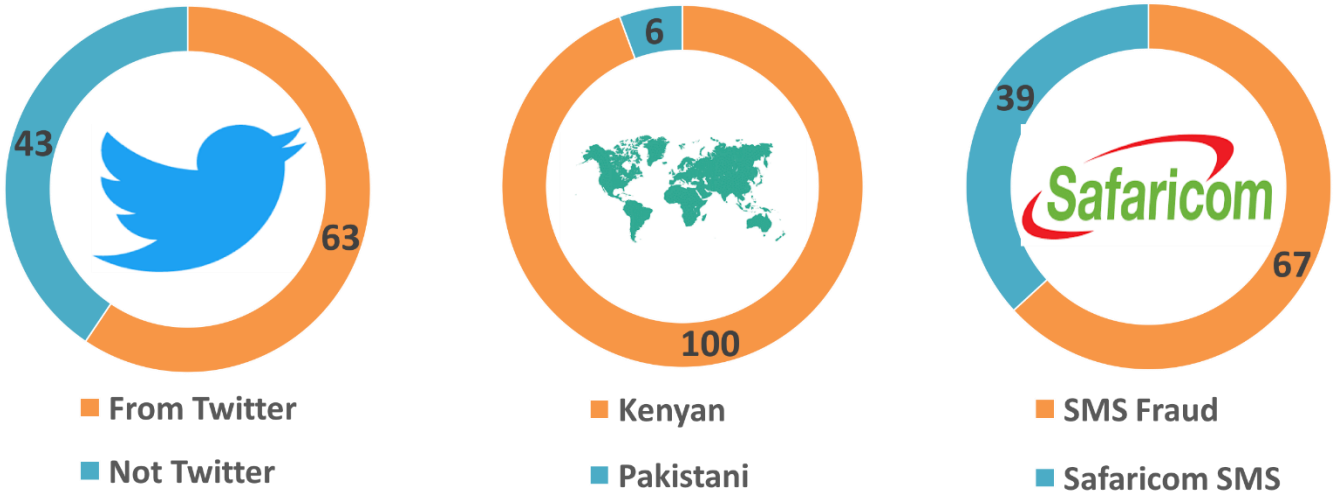
- Transactions SMS
- Payments and dues
- One-time pins
- Account recovery SMS

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

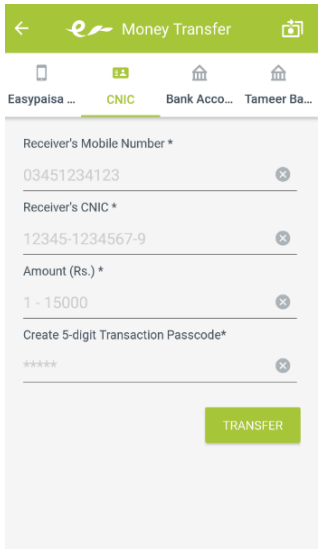
- We collected 106 SMS Examples

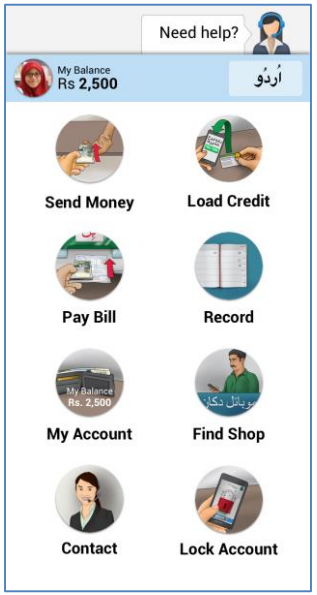


- Major categories: promotions, receipts, and loan offers
- Strongest indicators of fraud are URLs and phone numbers in SMS.

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

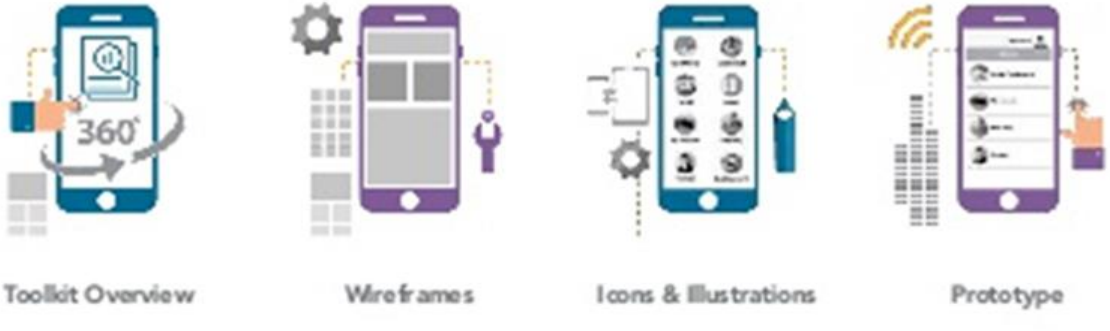




PROJECT 3: USABILITY OF MOBILE MONEY

Usability of Mobile Wallets

- Investigation into challenges in adoption of mobile money and mobile wallets
- Focus on Android Apps for mobile money
  - Applicable in areas with strong trajectory of smart phone adoption
  - Grid power, moderate population density, low cost android phones



Mobile Application Adoption

- Multiple challenges to adoption of digital financial services
- Specific focus – initial use of mobile financial applications
  - How easy is it for a customer to initially learn how to use an application
    - Mechanics of using the application
    - Use of mobile money
    - Possible limited knowledge of smart phone use
- Study approach
  - Introduce application prototypes to users
  - Have users step through basic mobile money tasks
  - Observe initial usability challenges
  - Probe to engage user on broader issues

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Description of study

- 118 participants recruited through convenience sampling
- Three step evaluation:
  - Pre-task Interviews about technology, device and financial services access, ownership and use
  - Task Based Learnability Evaluation
  - Feedback on Learnability improvement
- Three versions of applications
  - Local Mobile Network Operator's Mobile Wallet (n = 30)
  - Grid Impact's wireframe Application (n = 48)
  - Modified Karandaaz Application (n = 40)
- Participant Recruitment
  - Lower and non-literate participants
  - Borrowers of a local microfinance organization
  - In person (in Urdu and Punjabi)

Results on usability

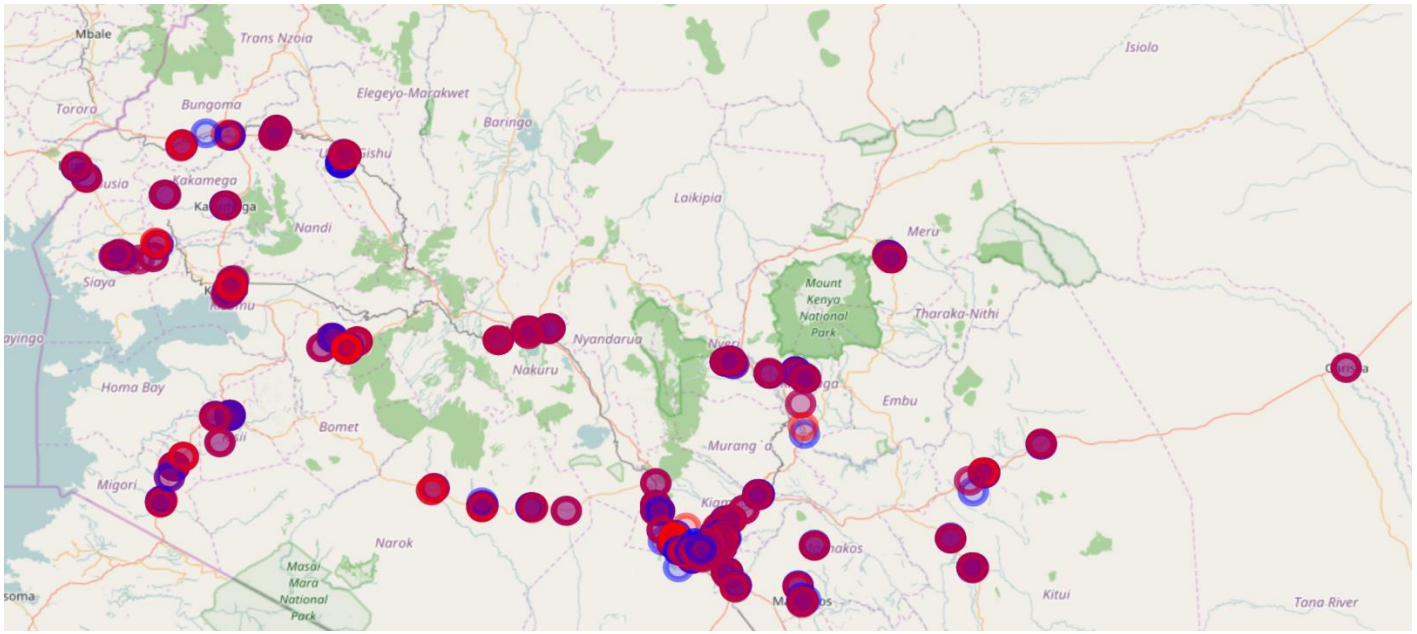
- Effectiveness should be the metric for learnability, time taken to complete a task cannot be used as a metric like usability
- Previous exposure or domain knowledge improved learnability, because users mapped new tasks to existing knowledge
  - Average time taken by participants with OTC exposure : 5.30 minutes
  - Average time taken by participants without OTC exposure : 8 minutes
- Preference of audio help for improving learnability (66%), followed by video help

"Written text might be misinterpreted but voice and audio explain it really well. Reading takes time and needs interpretation"

Broader results

- Lack of knowledge about existence of mobile wallets
- People are really ready to adopt the mobile wallets if they are designed appropriately
- App adoption barriers included:
  - lack of conceptual clarity regarding the origin of financial account and the flow and source of funds,
  - perceived risk of incorrect transactions and resulting financial loss,
  - lack of information on redress mechanisms for such wrong transactions
- Women saw wallets as opportunities to empower them, by making transactions from their home
- Participants considered wallets secure and more private

"I can transact from home and will not need to go to city after burning fuel worth 150 rupees and spending time as well. I can do something else in the same time. There is no mobile money agent shop in our nearby village but there is 4G internet"



PROJECT 4: DATA ANALYTICS

Phone upgrades in remote community cellular networks

- Problem: understand distribution of mobile phone handsets
  - 2G vs. 3G vs. 4G
- What is the upgrade path across technologies
- Remote community cellular network
  - Off grid cell networks (village base stations)
  - Low cost deployment (10K USD)

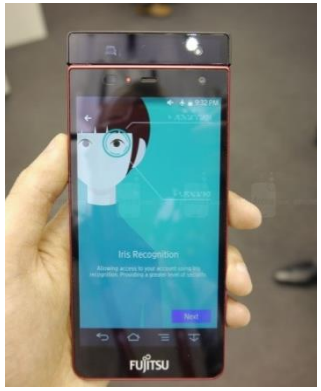
Methodology

- Cell tower logs
  - Record of every phone connection to base station
  - Type Allocation Code (TAC) indicates model
- Community cellular logs
  - Years of data from deployments in Indonesia and Philippines
- Analysis
  - Phones associated with the community
  - Sharing of phones
  - Upgrades and downgrades

Sample results

- 4G phones common even though network does not support 4G data
- Most upgrades from 2G to 4G, skipping 3G
- Users of 4G phones less active on network
- Sharing most common with 2G phones
- Upgrades commonly done by young, handing off old phones to family members





PROJECT 5: UNDERSTANDING THE ANDROID ECOSYSTEM FOR DFS

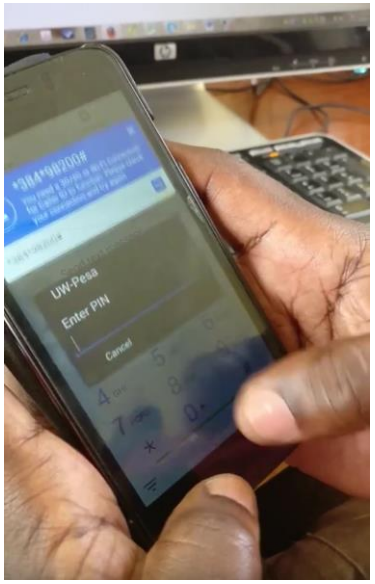
Android devices for DFS

- 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



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
- Plan to implement on top of CommunityCellularManager for local deployment
- Extension to support interaction across multiple instances
  - Implement interledger protocol

Goals for UW-Pesa

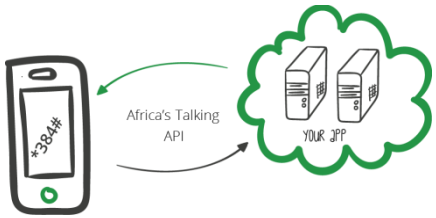
- Demonstration site for mobile money technologies
  - Internal learnings
  - External education and outreach
- Testbed for experimentation
  - Usability testing
  - Integration testing
  - Workflow

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

MEDIC MOBILE™

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

AADHAAR
UNIQUE IDENTIFICATION AUTHORITY OF INDIA

NPCI
भारतीय राष्ट्रीय भुगतान निगम
NATIONAL PAYMENTS CORPORATION OF INDIA

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Collaborators

DFS LAB

FINJA

MicroSave
Market-led solutions for financial services

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

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

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