Digital Financial Services Research Group

Computer Science & Engineering at the University of Washington

6 Month Progress Report

EXECUTIVE SUMMARY

The University of Washington, with the support of the Bill and Melinda Gates Foundation, has established the Digital Financial Services Research Group (DFSRG) to investigate technologies that will improve the ability of banks and mobile operators to deploy Digital Financial Service (DFS) products that reach the poor. Our goal is to develop and deploy technological solutions to specific challenges that impede the introduction and wide scale deployment of these financial products.

In the first 6 months of the grant, we have focused our efforts towards establishing the project, conducting formative research and identifying opportunities within the specific challenges areas. This work has allowed us to contribute important landscaping research to DFS and to begin to identify a research agenda for the broader DFS community. In addition, it has laid a foundation we can leverage to prototype and deploy new technologies.

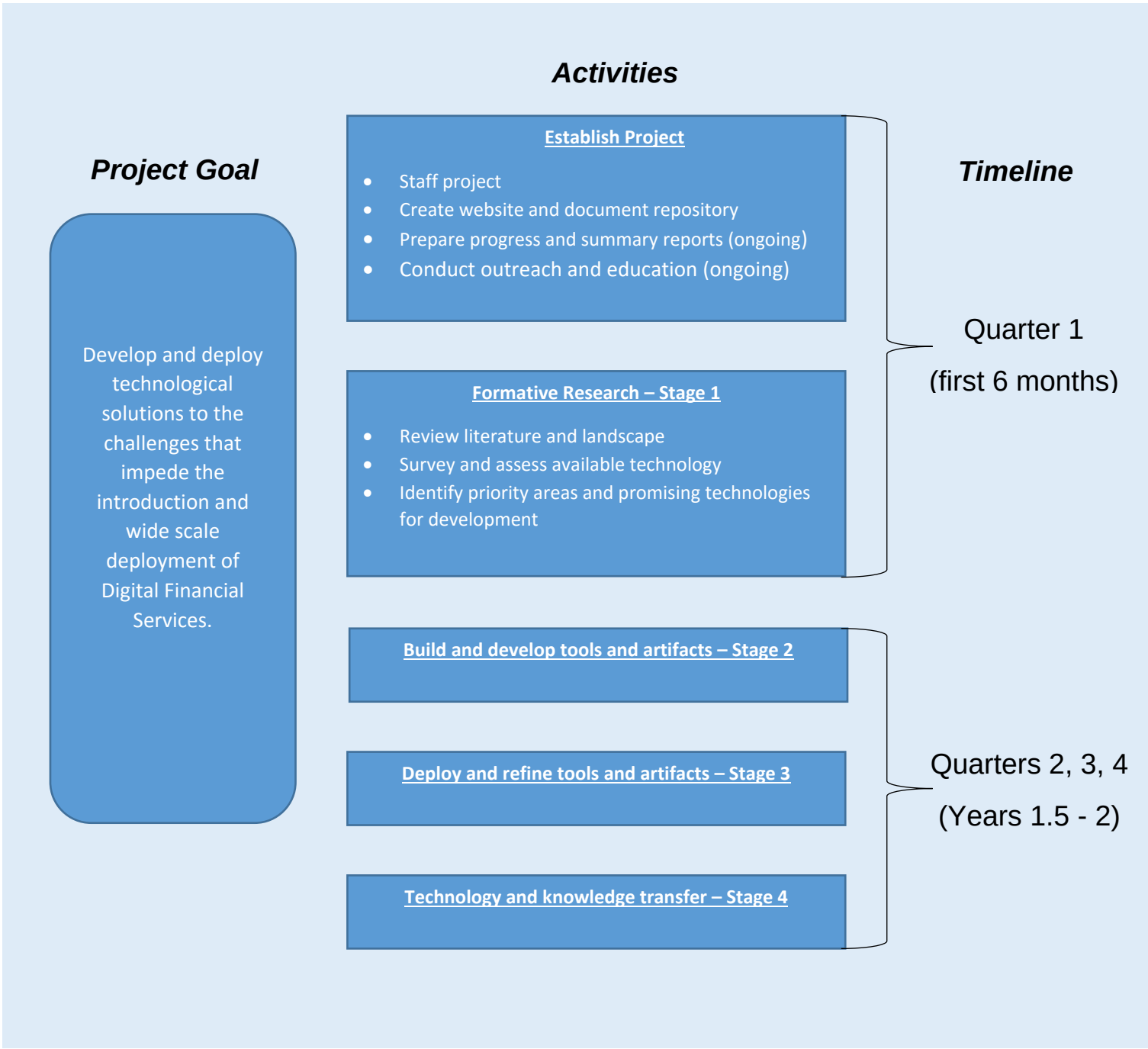
Our work has benefitted from the progress we've made in establishing the project. Specifically, by making key hires and increasing our public presence, we have significantly expanded our group's ability to communicate our work. Additionally, our global outreach activities have expanded our network and helped us identify potential partnerships. A recent trip to Pakistan by our Director, Richard Anderson, underscored the potential for the impact of our work and highlighted the availability of eager partners in DFS.

Our initial investigations and landscaping exercises have allowed us to strategically approach the set of previously defined challenge areas. These background results have highlighted gaps and opportunities in the areas of Security & Fraud, Usability and Data Analytics and informed our decision to apply deeper focus to these areas in the next quarter.

One key highlight of our focus on the security pillar is our research on Android App Security. It reframes previous claims that painted a dim picture of the security landscape for financial applications and defines a path towards addressing these security concerns through a set of best practices. Most importantly, this work serves as the beginning of a set of audit and verification tools, for which we have already received strong interest from a mobile operator.

In the next 6 months, the DFSRG hopes to continue to build upon the momentum generated and begin to prototype and develop new technologies born out of our early landscaping and investigations.

PROJECT PLAN



ACTIVITY OVERVIEW

Establish Project	
Activity	**Status**
Project Staffing	
Hired post-doctoral fellow (start date September 1)	Complete
Hired Research Coordinator	Complete
Administrative	
Launched website	Complete
Developed logo and branding	In progress
Produced 6 month progress report	Complete
Talks	
Change Seminar, March 2016	Complete
IIT Delhi, February 2016	Complete
PATH, Digital Health Solutions group, August 2016	Complete
ICTD Open Session on Digital Finance, June 2016	Complete
BMGF presentation on Level One for Research, March 2016	Complete
Education	
Undergraduate Research Seminar, Winter 2016	Complete
Graduate Research Seminar, Autumn 2015	Complete
Outreach	
EPAR, August 2016	In progress
MicroSave, April 2016 (Lucknow) and July 2016 (Seattle)	Complete
Harvard Center for International Development, June 2016	Complete
Microsoft Research India, April 2016	Complete
ITU Pakistan, August 2016	Complete
Meetings	
Weekly internal project meetings	Ongoing
Monthly meetings with FSP PO	Ongoing
Launch meeting with FSP, January 2016	Complete
Kickoff meeting with Caribou Digital, February 2016	Complete
Planning meeting with Caribou Digital, July 2016	Complete

Formative Research		
Activity	**Status**	**Application/Use**
Landscaping		
Identified priority research areas	Stage 1 - Complete	Informing future projects
DFS Computer Science Literature Survey	Stage 1 - Complete	Research brief available on website
ICTD Open Session on DFS	Stage 1 - Complete	Research brief available on website
Security		
Android App Security	Stage 1 – Complete Stage 2 – Starting	Research brief available on website
Infrastructure		
USSD Investigation	Stage 1 - In progress	Currently a research artifact. Will likely be expanded into a technology.
USSD Menu Systems	Stage 1 - Complete	Currently a research artifact. Provides a foundation for demo lab simulator.
Usability		
Application Behavior Documentation	Stage 1 - Complete	Currently a research artifact
Mobile Money Pricing Documentation	Stage 1 - Complete	Currently a research artifact
Data Analytics		
Data Set Documentation	Stage 1 - Complete	Currently a research artifact
Helix Data Set Exploration	Stage 1 - Complete	Currently a research artifact
Helix Data Set Research Tools	Stage 1 - In progress	Will make tools publicly available
Agent Network		
Simulation Exploration	Stage 1 – Complete Stage 2 – Starting	Technology to provide foundation for demo lab simulations
Demo Lab		
UWPesa	Stage 1 - In progress	Technology to provide foundation for demo lab simulations
USSD Integration	Stage 1 - In progress	Technology to provide foundation for demo lab simulations

ACTIVITY DETAILS

Establish Project

The DFSRG has used the first quarter of its grant to make significant headway into this activity pillar. Key hires and important administrative projects will allow us to accelerate and communicate our work while strategic outreach and education efforts are extending the reach and recognition of our group.

Project Staffing

Staffing the project has been an early focus as we seek to round out and complement the skill sets and experience of the DFSRG team.

Key hires include Shrirang Mare as a Postdoctoral Research Fellow. Shrirang recently completed his PhD in Computer Science at Dartmouth College where worked on authentication devices. His research focuses on security and privacy issues in pervasive computing, particularly in healthcare, usable security.

In addition, Ashley Hartz is the new Research Coordinator for the DFRG group. She brings a background in international development, with a focus on project management, evaluation, and research.

Finally, two undergraduate research assistants and three graduate research assistants have provided support for ongoing projects as well as contributed new work to the group.

Administrative

We have launched our initial website under the UW CSE department page at http://dfs.cs.washington.edu/. It provides an overview of the project and its faculty as well as functions as a resource for the greater research community. We've published our research briefs and we plan to make future tools and research available here. We've also begun to develop our logo and branding identity, which we expect to evolve as the program grows.

Finally, we've prepared this report to inform the BMGF of our progress at this point and will continue regular updates up to our formal 1 year Annual Report.

Talks

As part of our strategic outreach efforts, our faculty has organized and delivered several talks dedicated to technological issues in DFS. These efforts, spanning from the United States to India and Pakistan, have increased awareness of the group's work in the wider DFS and ICTD space while allowed the group to prioritize its strategic objectives and refine its research agenda.

Of particular note is the Open Session at the ICTD2016 Conference in Ann Arbor, which introduced the topic of digital financial services to the ICTD research community and identified many promising research questions. The panelists, with backgrounds ranging from computer networks to ethnography, presented various perspectives on the most interesting opportunities for future research, and the audience contributed questions and ideas to establish a community-sourced future research agenda for DFS. The proceedings of this session are available on our website as a research brief.

Education

The DFSRG Faculty has undertaken several educational initiatives which have served to recruit and educate new student researchers, improve the faculty's knowledge and teaching skills in the DFS space and extend the reach of the DFSRG across campus. These seminars focused on a selection of ICTD papers with an emphasis on Financial Services for the Poor.

The seminars were well received by students and could result in new interest in the group and its work. They also informed the creation of a summary document to help others offer DFS seminar.

Outreach

The DFSRG has conducted selective and strategic outreach efforts aimed at initiating potential new partnerships and collaborations and expanding awareness and knowledge of the group. These outreach efforts have proved fruitful in a few notable ways. First, meetings with MicroSave have opened up further access to the Helix Data Set, which will allow the group to build a set of tools around the data to assist other researchers. Secondly, several new collaborative opportunities with the Evans School Policy Analysis and Research Group at the University of Washington have emerged, indicating the potential for broad and multi-disciplinary work in DFS, particularly in regulation and policy trends.

Meetings

In the group's internal weekly meetings, researchers have presented on interesting and relevant findings with the aim of encouraging collaborative work and building shared knowledge. Monthly meetings have allowed the group to keep the FSP PO updated on current activities and challenge areas. In addition, meetings with Caribou Digital are building a pathway for collaboration, particularly in the area of the Demo Lab.

Formative Research

Landscaping

Through landscaping and review exercises, the group has begun to survey and assess the available technology for promising areas for development and has identified priority areas for further research. Security, usability and data analytics have emerged as important topics and the group will focus new research on further expanding understanding and technology to address specific challenges in those areas.

A landscaping activity of particular importance is the "Review of the Computer Science Literature Relating to Digital Financial Services." This study summarizes the existing computer science research relating to digital financial services in the developing world. Other researchers will find it helpful in that it provides a comprehensive list of background information from the computer science community and identifies major gaps in the current research base, correlating those gaps to core challenge areas within DFS. An annotated bibliography of all 46 relevant research papers accompanies the work.

Security

Security has been identified as a priority area. The DFSRG has responded to prior work, which enumerated the glaring security vulnerabilities in existing DFS products. DFSRG researchers

conducted a computer security review of 197 current Android applications for mobile money. Based on a new systematic threat model for DFS products, they argue that previous claims about vulnerabilities are not as dire as they appear, and they offer a novel analysis of organizational policies around specific Android apps. Additionally, to understand software development practices, they conducted interviews 7 developers from Africa and South America and conclude that although attack vectors are present in many apps, service providers are generally making intentional, security-conscious design. This paper, titled “Let's Talk Money: Evaluating the Security Challenges of Mobile Money in the Developing World” has been accepted to appear at the 2016 ACM Symposium on Computing for Development, to be held in Nairobi, Nov 18-20, 2016.

This work paves the way for a clear path towards addressing security in financial applications through a set of best practices and audit and verification tools. Proof-of-concept has been established through the paper’s reception and additional feedback from meetings with mobile developers. Thus, we are beginning the process of bringing this work into the next stage, where we will build out a prototype of audit and verification tools.

Infrastructure

The group’s work in infrastructure has concentrated on exploring how USSD can help address the specific challenge areas identified. Initial investigation has prompted the group to consider building a USSD technology. In addition, the group has documented the functions of USSD menu systems from several mobile money applications, which will provide an important foundation for work on a USSD simulator.

Usability

The DFSRG has undertaken documentation projects to examine specific processes, such as PIN resets, cancelling transactions, and balance requests to look for security or usability issues. In addition, we investigated and documented mobile money pricing structure to better understand see how pricing influences behavior and identify further research opportunities. These documentation projects have provided a clearer understanding of opportunity areas and could potentially be developed into helpful tools for the DFS research community.

Data Analytics

The group also conducted documentation projects in data analytics which led to an initial cleaning and exploration of the Helix Data Set to learn more about security concerns of agents in Pakistan. We are beginning to develop a set of publicly-available research tools around the Helix Data Set to support broader research efforts and access to the data set.

Agent Network

We have begun investigations into creating an agent network simulation. This will open up a wide range of research possibilities and serve as an environment to test new technologies.

Demo Lab

In collaboration with the DFS Innovation Lab, the DFSRG is currently working towards the establishment of a DFS Demo Lab, with the purpose of providing a hands-on experience to experiment with various security-related protocols, conduct usability studies, rapidly prototype product design and test the interaction of different mobile money schemes and hardware. In

addition, the Demo Lab will function as a road show, allowing demonstration of various DFS technology.

The DFSRG has begun prototyping a back end to allow basic mobile money simulations as well as simple Android applications. The group will continue to work closely with the DFS Innovation Lab to identify and build demo platforms.

ROADMAP

In the next 6 months, the DFSRG expects to expand our activities into the next phases of the project plan, namely building and developing tools and artifacts. Our formative research, which we will continue into the next 6 months, has allowed us to conduct judicious landscaping to identify research areas. In the next quarter, we will leverage our learnings to focus on completing small projects and prototyping technologies as well as identifying areas for larger scale implementation. In addition, we will continue our outreach efforts to identify new partnerships and explore further collaboration.

ABOUT THE DIGITAL FINANCIAL SERVICES RESEARCH GROUP (DFSRG)

The University of Washington, with the support of the Bill and Melinda Gates Foundation, has established the Digital Financial Services Research Group to investigate technologies that will improve the ability of banks and mobile operators to deploy Digital Financial Service (DFS) products that reach the poor. The goal is to develop and deploy technological solutions to specific challenges that impede the introduction and wide scale deployment of these financial products. Low profitability, lack of client demand, and the outright failure of many DFS launches can be traced back to difficult barriers and frictions that hinder the business model and scalability of DFS systems. Many of these barriers and frictions could be addressed by high potential emerging technologies but often the requisite translation of these technologies from the lab or from other sectors into usable tools for the DFS space is not happening with the necessary urgency.

The following set of DFS problems have been identified as the highest priority for technology innovation:

1. Fraud and cyberattacks
2. Proximity payments user experience
3. Identity and on-boarding
4. Analytics for product development and risk scoring
5. CICO agent recruitment, training, and management
6. Financial management and budgeting by end users

With this initiative we will accelerate the creation or translation of high potential emerging technologies that have the potential for dramatic improvements in efficiency, speed, scalability, cost, security, and client value. The DFSRG brings together a group of top scientists and

technology developers from a wide variety of fields to collaborate and build technology that will improve merchant payments, client onboarding, agent management, and other pain points in DFS systems. High potential ideas will be developed into prototypes and tested in the field with mobile operator partners and banks.

The Group

- **Richard Anderson** (PhD Stanford University) is a professor of Computer Science and Engineering at the University of Washington. He leads the ICTD group at University of Washington and oversees the development of Open Data Kit, a suite of mobile data collection tools. The work in ICTD spans multiple technologies and domains including mobile applications, text messaging, data integration and visualization, and IVR. He is also a founder of Projecting Health, a community-led video education initiative in India. He has worked closely with PATH since 2009 as a member of the Digital Health Solutions Group focusing on projects involving mobile technology, data reporting, behavior change communication, and managing the vaccine cold chain.

- **Franzi Roesner** (PhD University of Washington) is an assistant professor in Computer Science and Engineering at the University of Washington. Her research focuses on improving computer security and privacy for end users of existing and emerging technologies, including the web, smartphones, and emerging augmented reality platforms. Her work on application permissions in modern operating systems (including smartphones) received the Best Practical Paper Award at the 2012 IEEE Symposium on Security and Privacy, her work on security and privacy for augmented reality was featured on the cover of the Communications of the ACM magazine, and her defense for tracking by social media widgets on the web was incorporated into the Electronic Frontier Foundation's Privacy Badger tool.

- **Tadayoshi Kohno** (PhD UCSD) is the Short-Dooley Professor of Computer Science & Engineering at the University of Washington and an Adjunct Associate Professor in the UW Information School. His research focuses on helping protect the security, privacy, and safety of users of current and future generation technologies. Kohno is the recipient of an Alfred P. Sloan Research Fellowship, a U.S. National Science Foundation CAREER Award, and a Technology Review TR-35 Young Innovator Award. Kohno has authored more than a dozen award papers, has presented his research to the U.S. House of Representatives, was profiled in the NOVA ScienceNOW "Can Science Stop Crime?" documentary, and is a past chair of the USENIX Security Symposium. Kohno is also a member of the U.S. Government's Defense Science Study Group, the National Academies Forum on Cyber Resilience, the IEEE Center for Secure Design, and the USENIX Security Steering Committee.

- **Kurtis Heimerl** (PhD UC Berkeley) will join the Computer Science and Engineering department as an Assistant Professor in the fall of 2016. Kurtis' research interests span information and communication technologies and development (ICTD), human-computer interaction, and networks and systems. He was recognized by MIT Technology Review with a TR35 Award in 2014 for his work on The Village Base Station (VBTS), a low-cost,

low-power system for providing small-scale, locally-owned cellular networks in rural communities that lack existing cellular coverage. After building the one of the first community cellular networks in a small village in Papua, Indonesia in 2013, Kurtis co-founded a startup company, Endaga, to commercialize the technology and bring VBTS to more communities around the world.

- **Shrirang Mare** (Ph.D. Dartmouth College) will join the DFSRG as a Postdoctoral Fellow in the fall of 2016. He is interested in security and privacy issues in pervasive computing, in particular in healthcare, usable security, and continuous authentication.

- **Ashley Hartz** is the Research Coordinator for the group. With a background in international development and program management, Ashley has worked across UN agencies, nonprofits and private companies to help manage and extend the impact of social development programs.

- Joining the faculty is a group of dedicated PhD and undergraduate students, as well as 3 research assistant positions