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MAS.965 / 6.976 / SP.716 NextLab I: Designing Mobile Technologies for the Next Billion Users
Fall 2008

Introduction to NextLab I

Designing Mobile Technologies for the Next Billion Users

Wednesday, September 3, 2008

nextlab

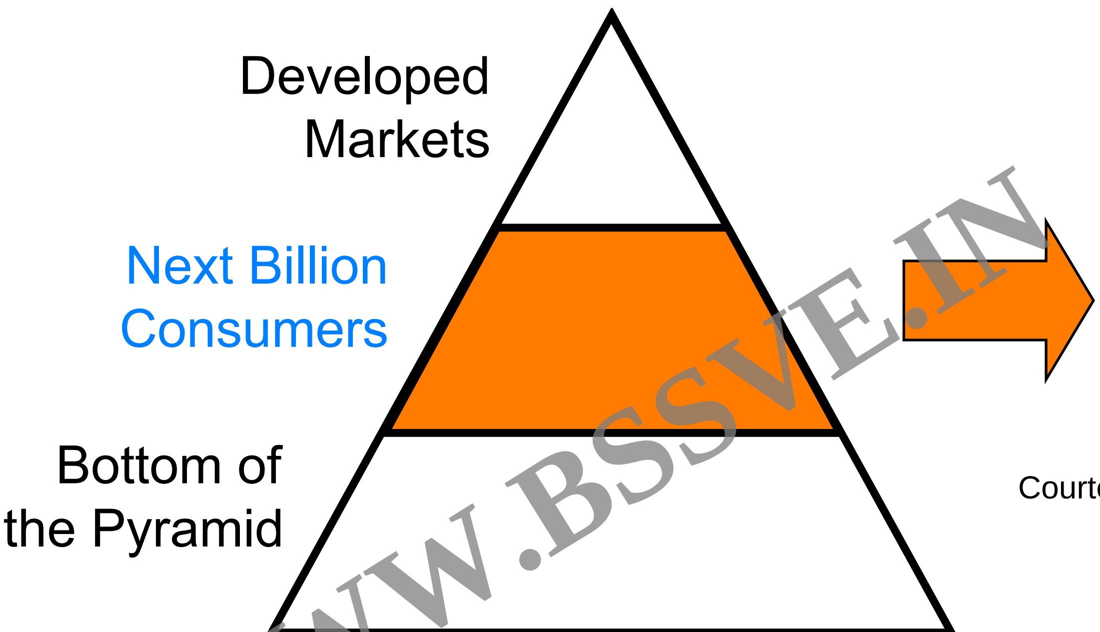
Welcome to NextLab I !

- **Designing Mobile Technologies for the Next Billion Users**
  - 6.976 / MAS 965 / SP.716
- **Instructors**
  - Jhonatan Rotberg, Lecturer, Media Arts and Sciences
  - Luis Sarmenta, Research Scientist, MIT Media Lab
- **Team Mentors**
  - Gari Clifford, Principal Research Scientist, HST
  - Rich Fletcher, Research Scientist, MIT Media Lab
  - Andrés Monroy-Hernández, RA, MIT Media Lab
- **Teaching Assistants**
  - Yoni Goldwasser (RA, HST)
  - Paul Yang (RA, ESD)
  - Luis Blackaller (Alumnus, MIT Media Lab)

Overview: Mobile Technologies for the Next Billion

The Next Billion

One billion of newly connected individuals within the next 3 years, throughout the developing world



Courtesy of Joseph Bamber. Used with permission.

World Mobile GSM Coverage (Jan 2005)

Source: http://www.coveragemaps.com/gsmposter.htm

Four slides of World Mobile GSM Coverage Maps removed due to copyright restrictions.

2005, 2006, 2007, and 2008 versions, from http://www.coveragemaps.com/gsmposter.htm.

The Mobile Phone Revolution

- **Before …**
  - no phones
  - no PCs
- **Now …**
  - mobile connectivity almost everywhere!
  - even lower-income people have it
- **Result … developing countries are leapfrogging traditional technologies**
  - even "simple" tech like SMS can have huge impact
  - innovations are happening in the developing world

Mobile Phone Application Areas for the Next Billion

- Economic Empowerment
- Education
- Health
- Community and Citizen Journalism
- Environment

- Some recommended web sites
  - http://ShareIdeas.org
  - http://textually.org

Examples: Economic Innovation

- **Just having communication helps!**
  - e.g., Fishermen in Kerala, India
- **Tools for Micropayments and Microfinance**
  - Mobile-to-Mobile transfer of cash and/or pre-paid credit via SMS
  - Empowers the unbanked
  - Empowers microbusinesses
  - Remittances
- **Other Mobile Services**
  - e.g., job ads, classifieds, etc.

Example: SMS Job Finder Service

- **User texts FINDJOB <JOB> to 123**
  - e.g., *FINDJOB DRIVER*
- **Service responds (via SMS text message) with …**

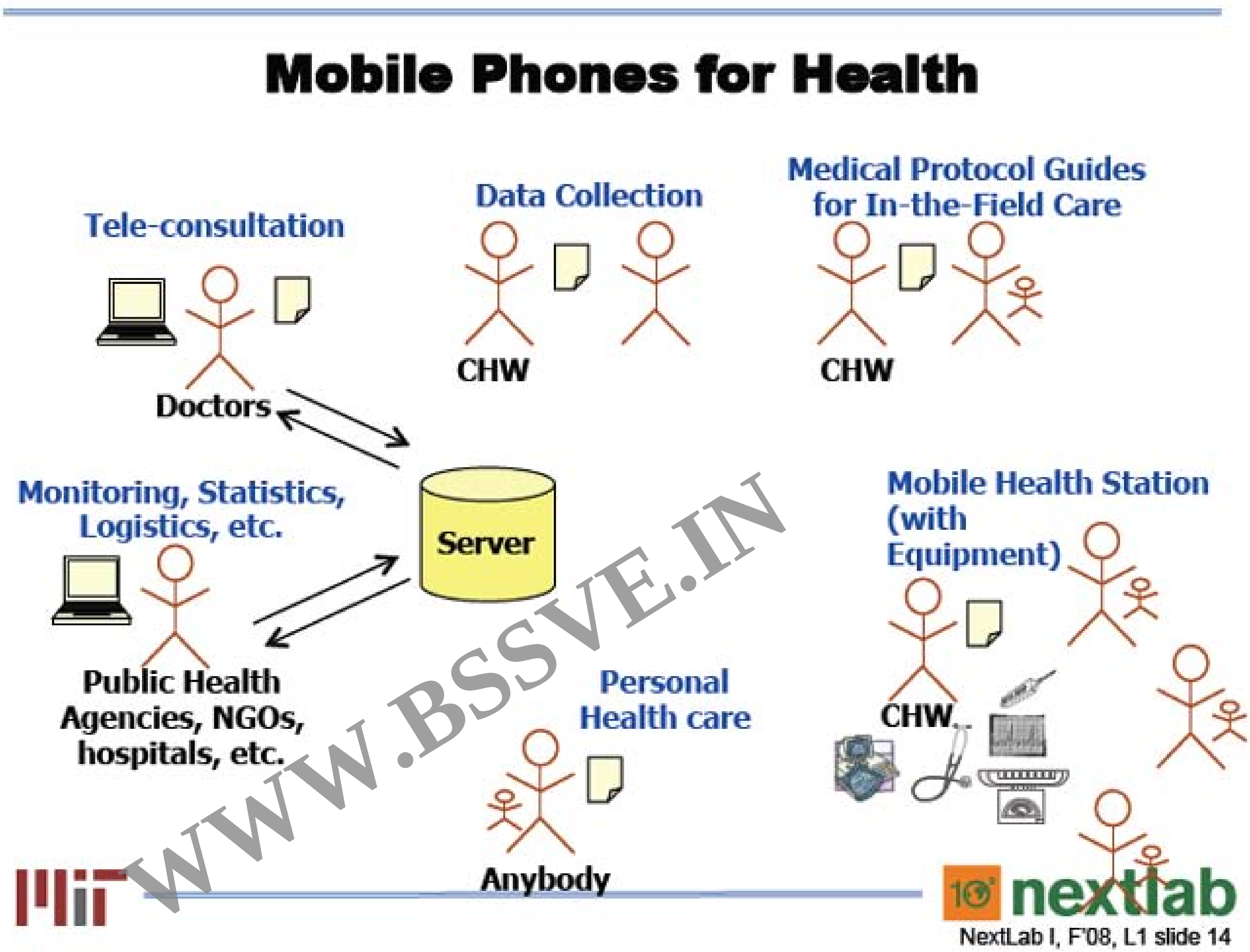
  Agency: JobsRUs. DRIVER needed as of 9/1/08, Call (987) 654-3210
- **Or, user can subscribe to alerts**
  - e.g., *FINDJOB SUBS DRIVER*

* based on a gov't service in the Philippines (ca. 2004)

Example: J2ME Applications

- Runs locally on the phone
  - but can include online component too
- Educational Games
- Tools
  - e.g., calculators for health workers, as well as personal use

Image: Luis Sarmenta


Mobile Phones for Health
Tele-consultation
Doctors
Data Collection
CHW
Medical Protocol Guides for In-the-Field Care
CHW
Server
Monitoring, Statistics, Logistics, etc.
Public Health Agencies, NGOs, hospitals, etc.
Personal Health care
Anybody
Mobile Health Station (with Equipment)
CHW
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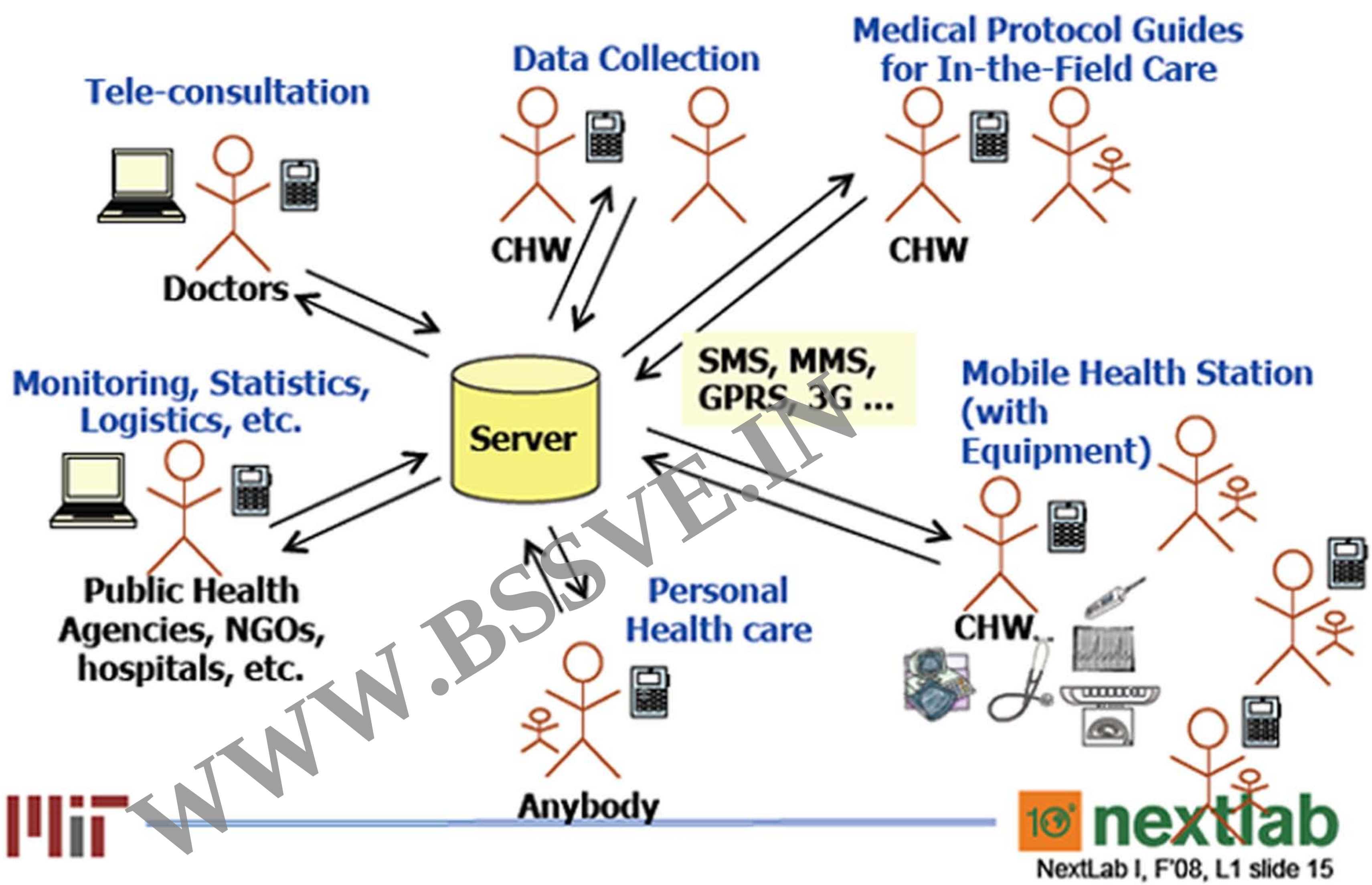
NextLab I, F'08, L1 slide 14

Mobile Phones for Health



Example: Mobiles Reducing Infant Mortality *

- Pesinet project in Mali and Senegal
- Local staff transmit infants' weights and symptoms via a Java app on their cell phones
- In Senegal, infant mortality rate fell from 120 per 1000 to 8 per 1000
- Self-financing, after installation costs covered by donors

* Reported July 20, 2007 by Balancing Act, Africa, issue 364

NextLab I, F'08, L1 slide 16

Social/Community Engagement

- **Mobile phones as a medium for coordinating community action**
  - e.g., Philippine “people power” in 2001 initiated by massive SMS chain – protest against Estrada
- **Mobile phones for democracy**
  - monitoring elections
  - reporting human rights abuse
- **Donations via SMS**

NextLab I, F’08, L1 slide 17

Environment

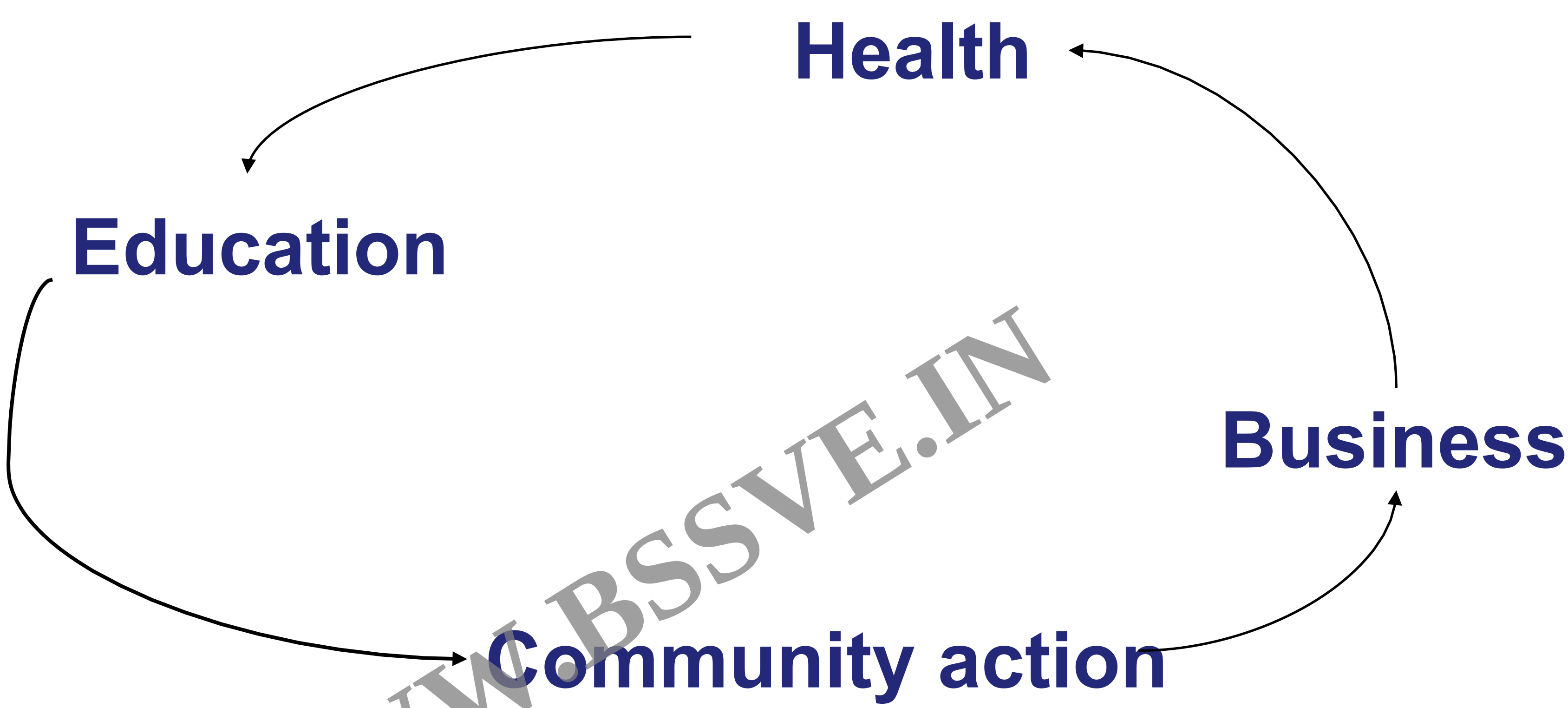
- **Surveying and Reporting**
  – including SMS and multimedia reports
- **Using cell phone network as a cheap and widely available data channel for sensor data**
- **Disaster Reporting and Management**
  – (e.g. Sahana)

E-government

- **Replace paper applications and unreliable/expensive/slow snail mail**
- **Access info and/or services from local/nation government**
- **Report info to the government**
  - e.g., smoke belching cars in Manila
- **Electronic I.D.**
- **Voting?**

NextLab I, F'08, L1 slide 19

A Virtuous Cycle of Development



BUT … Some Issues

- **Technical**
  - bandwidth
  - user interface
  - memory
- **Social and Cultural**
  - Is it socially / culturally appropriate?
  - How to design services for shared phones?
  - Literacy?
  - Government and Political Environment
- S
- **Economic**
  - Coverage?
    - improving
  - Cost?
    - of phones
    - of service
    - relative costs (e.g., SMS vs. voice vs. 3G)
  - Cut-throat business environment
  - Sustainability

Recommended Reading

- "Can the Cellphone Help End Global Poverty", by Sara Corbett, New York Times, 4/13/2008

Image removed due to copyright restrictions.
See photo at http://www.nytimes.com/2008/04/13/magazine/13anthropology-t.html

NextLab I
@ MIT

Conclusions so far …

- Mobile phones have a lot of potential impact
- Even “simple”-looking applications (e.g., text -based SMS apps) can be very powerful
- But … also need to be aware of other issues, both technical and non-technical (social, economic, literacy, cultural, etc.)

NextLab I @ MIT

- Discuss papers on the topic of mobile phones, and ICT in general, for Development
- Produce a solution using mobile phones to address a real need of real people in the real world
- Collaborate with an on-the-ground partner to get feedback, and develop a relevant solution
- Plan the sustainability of your technology

Mobile Phone Labs

- You are expected to develop a working prototype of your solution
- We will not teach programming during class hours
- But, we will have a NextLab wiki contain tips
  - SMS (and MMS) services
  - J2ME applications
- Nokia hardware (phones) will be made available to borrow, as needed
- But … we will emphasize learning platform- and manufacturer-independent concepts and techniques

Mobile Phone Labs Kit

(thanks to Nokia Research Center Cambridge)

- **N82 and N95**
  - cameraphone, GPS, TV out
- **E61i**
  - phone with QWERTY keyboard
- **6131 NFC**
  - mid-range phone with NFC (contactless RFID) reader
- **N810**
  - Internet tablet (not a phone)
  - big screen, GPS, camera, and QWERTY keyboard
- **2610**
  - low-end phone
  - (refurb pay-as-you-go phone for only $9.99!)

Images of phones removed due to copyright restrictions.

Why High-End Phones?

- **You can always simulate a low-end phone with a high-end phone … but not the other way around**
- **For some projects, only a few people (e.g., health workers) need to have these phones to serve many**
- **But also plan for the future**
  - prices for these are likely to continue to go down
- **In any case … we will emphasize designing solutions that can be used even without these phones**
  - e.g., SMS-based services and platform-independent J2ME

MIT ICT4D Projects (Spring '08)

(Instructors: Gari Clifford, Rich Fletcher, Jhonatan Rotberg, Luis Sarmenta)

- **Economic Empowerment**
  - Mosoko Mobile Marketplace (Nokia, Kenya)
  - Efficiency in Labor Markets (Assured Labor, Brazil)
  - Smart MicroLoans (ISF, India)
- **Health**
  - Pediatric care for Urban Poor (J. Hopkins & IRD, Pakistan)
  - Cervical Cancer Prevention (Dimagi, Zambia)
- **Education**
  - Knowledge Box "Virtual Internet" (Beehive School, Malawi)
- **Community Action**
  - Disaster Management (CRS, India)
  - FreePress (Hanantek, Bolivia)

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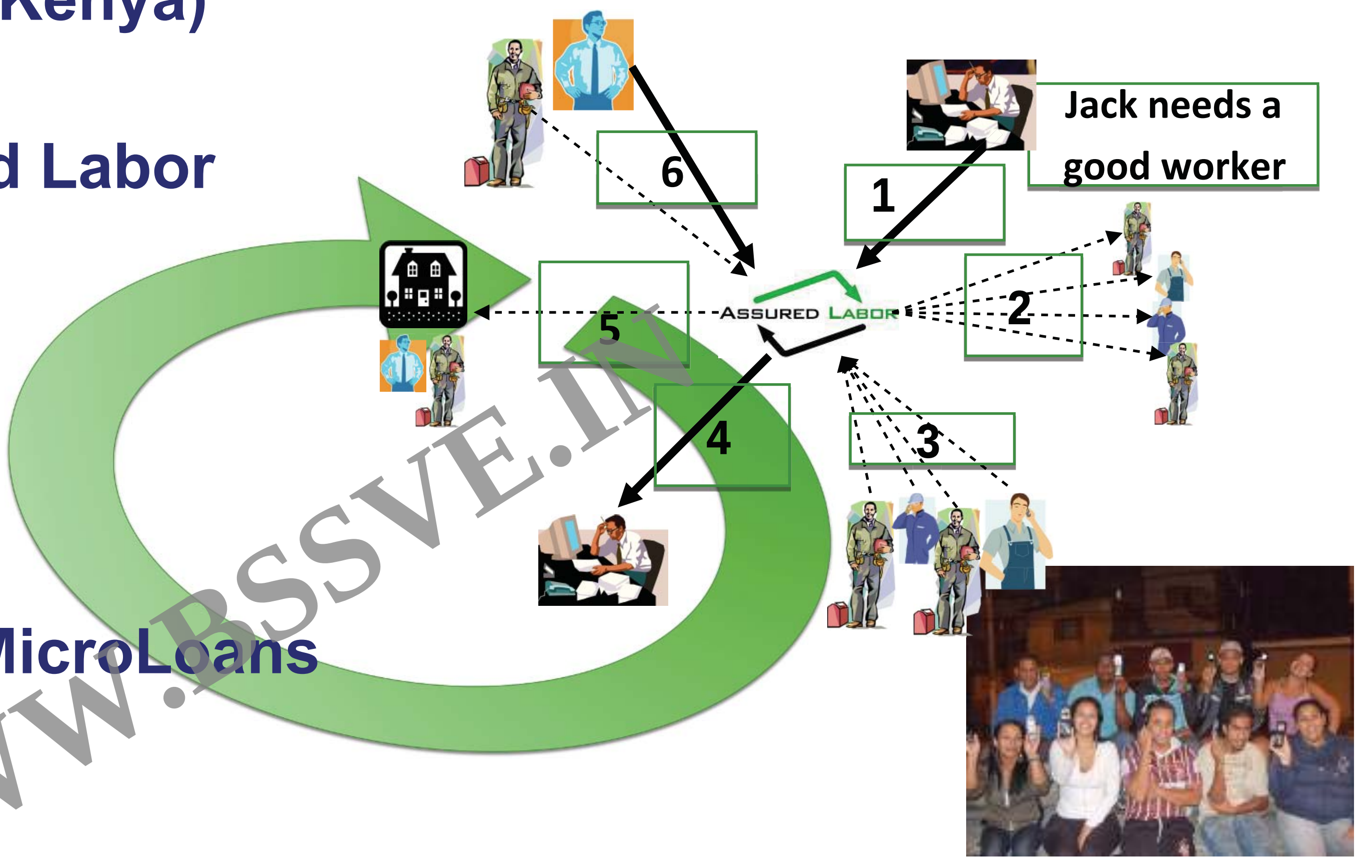
Economic Empowerment

- Mosoko Mobile Marketplace (Nokia, Kenya)
- Assured Labor (Brazil)



- Smart MicroLoans (India)

Diagram courtesy of Assured Labor. Photo courtesy of Joseph Bamber. Used with permission.

Health

- **Pediatric care for Urban Poor (Johns Hopkins & IRD, Pakistan)**

Courtesy of Aamir Khan. Used with permission

- **Cervical Cancer Prevention (CIDRZ, Zambia)**

Education

- **K-Box "Virtual Internet" (Beehive School, Malawi)**

Photo of students working on a computer removed due to copyright restrictions.

Community/Citizen Journalism

- **Disaster Management (Catholic Relief Services, India)**

- **FreePress (Hanantek, Bolivia)**


Photos courtesy of Vijay Umapathy. Used with permission.

Course Projects and Partners

NextLab Projects: Fall 2008

Economic Empowerment

PlaNet Finance: Mobile pre-screening for microfinance, Argentina

Macosa: Multilevel marketing for microfinance, Ecuador

ITESM (Monterrey Tec): Agriculture pricing for market efficiency and disintermediation, Mexico/Nicaragua

United Villages: M-commerce interface, India

Health

GE Healthcare: Tele-radiology with Ultrasound on Mobiles, Belize

CIDRZ: Mobile diagnostics for cervical cancer, Zambia

NextLab Projects: Fall 2008

Education

Telmex: Mobile social network for students in low-income communities, Mexico

ITESM (Monterrey Tec): M-learning for rural literacy instructors, Mexico

Environment and Community

Flow, Inc: Mobile/GIS InnovGreen Technology, Vietnam

Catholic Relief Services: Mobile Early Warning System for Disaster Management, India

The Next Billion in Our Neighborhood (with City of Boston)

Thrive in Five: Mobile services for parents of 0-5 year olds

Eat or Heat: Can we help people manage their money better?

Course Logistics

Basics

Class Meetings

Period: Fall 2008

Term: Monday, Wednesday from 1:00 - 2.30pm

Units: 3-1-5 (9 H-level units, 6 EDPs)

Class size: Maximum 30 students

Cross-listings

Graduate: MAS.965, 6.976

Undergraduate: SP.716 or 6.976

Prerequisites: Permission of instructor for undergraduates.

Course Deliverables and Grading

- Class participation and leading an in-class discussion of one of the papers designated for the course
(20%, individually graded)

- A working prototype that addresses the real needs of low-income community in a given developing country
(40%, team graded)

- A simple sustainability plan to ensure the project's long-term success
(20%, team graded)

- An end-of-term public presentation of all work performed during the semester
(20%, individually and team graded)

Project Trips

- **Teams who have matured their projects during the term will have the opportunity to send one or more of its members for free during IAP to spend time in their target communities**

- **The decision to finance the trip will be based on:**
  - Technical and conceptual advancement during term
  - Overall maturity of project
  - Justification for trip
  - Agreement on designation(s) between team members
  - Travel restrictions/political upheaval/safety concerns
  - Limitations on course resources

Course Format

Monday: In-class Discussions

- In-class Discussions consist of an 80 min session, once a week, wherein individual students will be designated one research paper to read and facilitate discussion during class.
- We expect to designate an average of three student-led discussions every class (20-30 mins each).

Wednesday: Guided Design Process

- Guided Design Process consists of a separate 80 min. session, once a week, in which student teams are expected to present completed project milestones to the class and submit their work to structured sessions of expert and peer reviews.
- We expect half of all teams to present each Wednesday, with the other half presenting the following Wednesday

Project Selection

Monday, September 8

- Projects will be presented to students during class
- Students will have until midnight to rank projects in order of preference, using surveymonkey.com

Tuesday, September 9

- Course staff will assess student preferences, individual skills and specific project needs, and will assemble the teams

Wednesday, September 10

- Course staff will announce teams in class, and students will get together to plan their contacts with project partners and overall strategy. They will hear about needs assessment, and advice from students in previous semesters.

Note: we will make every effort to accomodate top student preferences, but we cannot guarantee top choice for everyone

NextLab
Media Component

MAS.965 / 6.976 / SP.716 NextLab I: Designing Mobile Technologies for the Next Billion Users
Fall 2008

Project Proposals

Monday, September 8, 2008

Agenda

- Special NextLab Features (Fall 2008)
  - NextLab Media Component
  - Possibilities for Launching in Real World Networks (América Móvil)
- Project Selection Process
- Project Proposals
- Agenda for Next Class

NextLab Media Component

Project Selection Process

Project Selection Process

- Enter your preferences online, through the link at http://nextlab.mit.edu/ entitled "Project Selection"
- For each project, rank your preference for it (top choice=1)
- If you don't have a strong preference between two or more projects, you may give the same rank to more than one project

  e.g., if you prefer education-type projects, but do not really care whether it is with Telmex, ITESM, or Boston's Thrive in Five, then rank of all of these with a "1"
- All project proposals will be posted online at nextlab.mit.edu
- Deadline for project selection is Midnight today
- Project teams assembled Tuesday, announced Wednesday

NextLab Projects: Fall 2008

Economic Empowerment

- Giving Farmers a Fighting Chance (Monterrey Tec, Mexico/Nicaragua)
- Multilevel marketing for microfinance (COBIS, Ecuador)
- Mobile pre-screening for microfinance (PlaNet Finance, Argentina)
- M-commerce interface (United Villages, India)

Health

- Mobile diagnostics for cervical cancer (CIDRZ, Zambia)
- Ultrasound Outreach to Rural Villages (GE Healthcare, Belize)
- Real-time Mobile Network for Mid-Wives to Reduce Maternal, Neonatal Mortality (Vaatsalya, India)

Education

- Mobile social network for students in low-income communities (Telmex, Mexico)
- M-learning for rural literacy instructors (Monterrey Tec, Mexico)

Environment and Community

- Disaster Management (CRS, India)
- Mobile Sensors and GPS Mapping for Farmers (InnovGreen, Vietnam)

Next Billion in Our Neighborhood

- Thrive in Five Baby Blog (Mayor's Office, Boston)

Project Proposals

See the Compiled Project Proposals presentation.

Project Selection

Deadline: Midnight tonight

Rank Each Project
(Multiple 1st / 2nd / 3rd Choices Allowed)

Economic Empowerment

- Giving Farmers a Fighting Chance (Monterrey Tec, Mexico/Nicaragua)
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Next Billion in Our Neighborhood

- Thrive in Five Baby Blog (Mayor's Office, Boston)

Agenda for Wednesday's Class

- Announce team-project formations
  - MIT students (technical, non-technical)
  - Emerson College students (embedded videobloggers)
- Everyone's personal introduction as part of their team
- Explain In-Class Discussions process
  - Designation of one (or 2) papers per student
  - Time allocated 20-30 mins per paper/student
- Explain Guided Design Process
  - Project Milestones
  - Presentation and feedback
  - First step of design: Needs Assessment (Gari C.)

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Project Proposals

Monday, September 8, 2008

NextLab Projects: Fall 2008

[OCW Note: This is the complete list of proposals considered]

Economic Empowerment

- Giving Farmers a Fighting Chance (Monterrey Tec, Mexico/Nicaragua)
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Next Billion in Our Neighborhood

- Thrive in Five Baby Blog (Mayor's Office, Boston)

Following is a selection of project proposals reviewed during this class session.

Economic Empowerment

Advisors:
Elisabeth Megally
Esmeralda Megally

Giving Farmers a Fighting Chance:

Transforming the Rural Economy in Zacatecas through Mobile Technology

Instituto Tecnológico y de Estudios Superiores de Monterrey
Campus Zacatecas

MEXICO

Monday, September 1, 2008

6 Slides - 6 minutes

Need or Problem Identified

Much of Zacatecas State –one of the most beautiful and traditional in Mexico - has semi-desert terrain, coupled with low per capita income. Despite its dry climate, agriculture is a key economic driver. Zacatecas produces more beans, chili peppers and nopales than any other state, and is a major producer of agave, grapes, jicima, peaches, and tomatoes.

Farmers lack communication between their rural communities and cannot establish equitable pricing, let alone distribution or storage centers. As a result, they are at the mercy of middlemen who pay next to nothing for produce, and these communities remain locked in a poverty cycle.

Project Objective and Description

- The objective is to enable farmers to communicate (and thus present a united front) that will enable them to escape the endless cycle of rural poverty that in turn accelerates the de-population of the countryside (Zacatecas sends more immigrants to the US than any other Mexican state).

- The description is to use peer-to-peer mobile technologies - easily adopted, understood, replicated, and maintained - in a rural area, whose deployment will enable farmers to communicate and collaborate such that they – not the middlemen – can determine fair prices for their crops and ensure a marginally better economic (and socially cohesive) future.

6 Slides - 6 minutes

Expected Results, Impact on Community

- The expected results are radically transformational. The ability to communicate and collaborate between rural communities would have immediate and long-term beneficial results. It is no stretch to say it would transform the rural economy from one of dependence on middlemen to one of self-sustainability. This model would be adopted by other states with similar demographic and economic profiles.
- The impact on these communities would have two immediate effects: retardation of immigration and improved ability to attract social programs that otherwise would never be implemented. These two factors often spell life of death for these communities.

Technology Guidelines

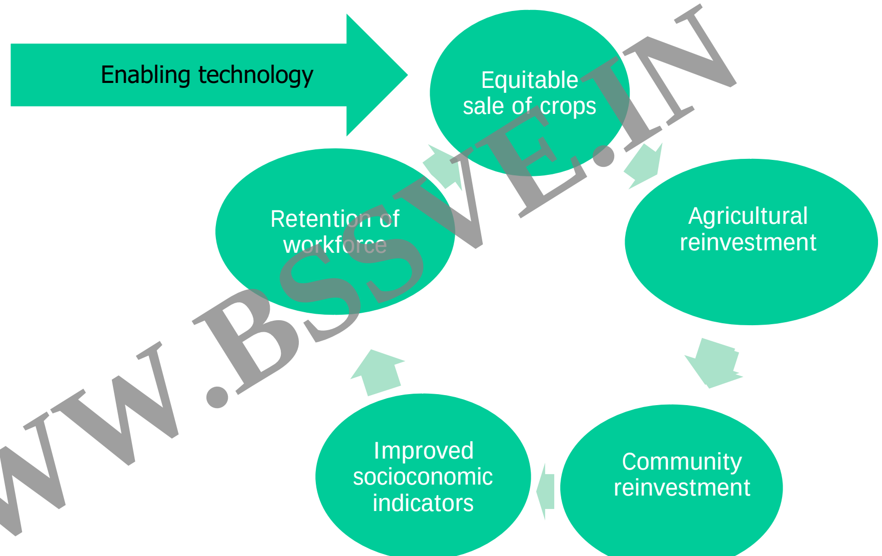
- Technology guidelines for this project are predicated on four factors:
  - ✓ Ease of adoption (implementation)
  - ✓ Ease of understanding (usage)
  - ✓ Ease of replication (across different locales)
  - ✓ Ease of maintenance (using continued functionality)
- Technology should be portable as opposed to stationary, and scalable (capable of data expansion/storage over time)

Map: Wikipedia.

6 Slides - 6 minutes

How is the Project Sustainable?

- The project is self-sustaining. The farmers and others with access to this technology will have the ability to command more equitable prices, in turn reinvesting their profits in a virtuous circle. This project (and its underlying technology) will act as an economic lever, giving them the ability to directly invest not only in the next season's crops but also their communities, sustaining them and in many cases averting abandonment.



6 Slides - 6 minutes

Describe your Organization and its Role

- ITESM Zacatecas, part of the ITESM system, was founded by an MIT graduate and attempts to model itself closely on MIT's commitment to solving the world's biggest problems. It is the link between the rural communities of Zacatecas State, and technology and other assistance providers, acting as a consultant and bridge between these communities and those entities that can provide support. The communities themselves have no voice, individually or collectively, and are often overlooked by traditional support mechanisms (e.g., government, NGOs).

- ITESM Zacatecas neither asks for nor receives any funds or remuneration of any kind for its role as advisor and intermediary. It sees its role as providing a much-needed service to the people of rural Mexico as well as giving its students and faculty an opportunity to participate in a work of economic and social justice with tangible results.

Cobis MLM

Macosa SA

Ecuador

Problem: Inefficient Microfinance

- Experts agree that the biggest challenge facing microfinance is operational efficiency.
- Microfinance in most current incarnations is **labor-intensive**.

Outsourced Loan Prospecting

- Ever heard of Mary Kay?
- Cobis MLM is the multi-level sales business model applied to microfinance.
- Commissions are based on the final profit-per-customer going to the MFI.
  - Discourages volume-based blitzing
  - Encourages sustainable partnerships

Expanding Access

- Independent entrepreneurs drive expansion of the MFI.
- Communities become integrated around the idea of responsible saving and borrowing.
- Think of it as linear, dynamic village-banking.

How is the Project Sustainable?

- Portable methodology
  - Any MFI willing to invest in their IT can adopt the techniques we will be testing in the Cobis MLM project.

- Constantly expanding operations in each MFI
  - MFI must only respond to exponentially increasing demand.

Technology Guidelines

- All interaction between the MLM Agent (independent loan prospector) and the MFI can be done remotely, using handheld devices.

- This is where you come in.
  - We need to modify our existing mobile software.
    - Integrate with the new MLM modules.
    - Tags on each transaction for commission purposes.
    - Upload "on-the-spot credit scoring" results to the MFI in 2 modes:
      - Online (wireless)
      - Offline (periodic database syncs)
  - We plan to use .NET Compact Framework developer tools

Our Role

- **Macosa SA** is the Ecuadorian arm of the banking software company **Cobiscorp**.
- We have years of experience in:
  - developing and implementing core systems for MFIs and cooperatives.
  - ASP offering: outsourced IT for microfinance.
- In the Cobis MLM project, Macosa will be developing the MLM software modules to integrate with the pilot-site MFI's core banking system.
- For more info about the company, see www.cobiscorp.com/en

To download and read the Cobis MLM Project Overview, go to www.cobiscorp.com/Portals/0/IADB Application_Cobis MLM.pdf

6 Slides - 6 minutes

Mobile Pre-Screening for MFIs

PlaNet Finance Argentina

Argentina

Need or Problem Identified

Microfinance is a powerful tool to fight against poverty. However, **technological improvements** remain a key issue for the sector

•Very high operative costs of MFIs mostly due to extensive use of HR. Among principal identified issues, MFIs suffer an inefficient pre-screening process of microentrepreneurs

Loss of valuable time that increase the cost of credit for microentrepreneurs and prevents higher penetration of Microfinance in the market

And our response…

•To develop a screening process implemented through mobile technology, in order to reduce the *dedicated time per evaluation* and increase outreach of Microfinance Services

Project Objective and Description

- To improve the pre-screening process technology for prospective microfinance clients through a **handheld electronic device**, in order to capture and approve basic data directly in the field and in real time (no need for the credit officer to go back to the office to process the information).

- The result of this **pre-screening** is communicated to the loan officer a few minutes later helping him to decide to continue or not with the credit request.

- This system allows:
  - To reduce time required in the credit awarding process and cut off operative costs
  - To allocate more time for new clients prospection and to allow credit officer reach the most excluded populations

Expected Results, Impact on Community

- This project will contribute to an economic and social development for the poor:
  - by increasing the penetration of microfinance services, and
  - by improving the development of microenterprise: through the obtaining of major financing, microentrepreneurs can expand their economic activities

- The benefits for the MFI:
  - greater efficiency of the loan officers
  - reduction of costs
  - greater geographic outreach of the product
  - first step which might be followed by mobile scoring and mobile banking

Technology Guidelines

- PlaNet Finance Argentina, in collaboration with Experian (one of the three most important credit bureaus) and Compañía Financiera Argentina (CFA: one of the biggest suppliers of consumer loans in Argentina), will create a system to verify personal and commercial data as well as credit history, using mobile technology
- Experian will develop an Expert System of pre-screening prospects, using actual consumer data provided by CFA based on their historical lending portfolio
- PlaNet Finance will develop a Web platform to implement the expert system and to allow CFA credit officers to make an online request about microentrepreneurs general data
- **Support is needed to develop and implement the required technology that will serve as a link between the Web platform and handheld electronic devices**

How is the Project Sustainable?

- Firstly, CFA will conduct a pilot test of the Microfinance product, and it is very important because it is the worldwide pilot project for the company
- After this pilot project, it is planned that 94 branches of CFA will implement the same microfinance product, reaching more than 150,000 microentrepreneurs
- Through its extensive network distribution and its knowledge of how to deal with low-income people, CFA will be the biggest supplier of microfinance products in Argentina
- In the future, this innovative platform may be implemented in other financial products helping the development of mobile banking and mobile credit scoring
- PlaNet Finance assumes the commitment to disseminate this new technology through seminars, web sites and/or publications

Describe your Organization and its Role

- PlaNet Finance is an International Solidarity Organization whose mission is to fight against poverty by developing microfinance
- Based in Paris, the PlaNet Finance Group is active in more than 60 countries with an international network of 28 offices around the world
- PlaNet Finance Argentina, based in Buenos Aires, is an independent office delivering its consulting services in the South Cone
- For nearly ten years, PlaNet Finance has been contributing to the development of microfinance by supporting a wide range of institutions in the sector

Education

Team Advisor:

Andrés Monroy-Hernández

Mobile Social Network for Low-Income Students

Telmex Foundation, Instituto Carso Educación

Mexico

Need or Problem Identified

- A **BIG COMMUNITY** of Telmex Fellows in Mexico
  - **Students** (high school, undergrads, grads) with an excellent academic record and notable extracurricular activities
  - Brilliant "**human capital**"
  - HUGE **potential** group that can impact the social development of their communities

- **PROBLEM**: this community (social network)is
  - **THEY haven´t fully realized the EXTRAORDINARY value** they can generate and that they could have as a community
  - poorly communicated/networked/linked
  - "Sub-utilized","Wasted", "Non-engaged"
  - No value created (at least not evident to them and to Mexico)

Project Objective and Description

- Objectives:
  - "Un-lock" the power that lies within this social network (academic and social)
  - Stimulate participation and collaboration

- Develop an innovative social network platform based on mobile and web technology in order to:
  - Support the academic aspirations
  - User generated value & content
  - Facilitate the colaboration between members in social and academic programs, actions, campaigns
  - Enable the establishment of programs/campaigns
  - Encourge the participation of students in other projects and innititatives generated by other students

Expected Results, Impact on Community

- To empower more than 100,000 "fellows"
- New platform that can be "replicable" to other student communities
- Generate new ways in which students can communicate, collaborate, and make a contribution to their communities
- Leverage the value of this community by means of mobile technology
- Enable the creation of many social developmental activities based on mobile collaboration
- New motivational model to promote the use of mobile as an instrument of social activism within the student community

Technology Guidelines

- PLATFORM can be complemented by:
  - Mobile
  - Web based

- Current portal for Telmex Fellows community

  - www.interactuando.org

How is the Project Sustainable?

- Scholarships given by:
  - Telmex Foundation
- Operation and support by:
  - Telmex and Telmex Foundation
  - Instituto Carso Educacion
- Preferential fees for mobile services:
  - America Movil (largest mobile service provider in Mexico)

Describe your Organization and its Role

- Telmex –largest ISP in Mexico
  - 17 million customers
- Telmex Foundation
  - Philantropic Institution established since 1986
  - Programs: education, health , justice, culture and human development
- Instituto Carso Educacion
  - To be focused only in major education programs in Mexico
- America Movil – Telcel
  - Largest mobile service provider in LatAm (120 million customers)
  - In Mexico, Telcel more than 50 million customers

M-LEARNING-Quintana Roo

"Strategies for training community literacy instructors, based on new educational technologies and mobile devices"

Instituto Tecnológico y de Estudios Superiores de Monterrey

México

Problem Identified

- Research and evaluation of educational services offered by Consejo Nacional de Fomento Educativo (CONAFE) in the state of Quintana Roo, detected improvement opportunities in the learning processes given out to rural literacy instructors, young mexicans between 14 and 24 years old, from rural environments, with a minimum of a middle school education.

- During the academic year of 2006-2007 a total of **34,978 rural literacy instructors** taught 300,698 boys and girls nationally.

Objective of the project

- Research ways in which mobile devices can be used to strengthen the strategies that the CONAFE uses to train rural literacy instructors, and to build a mobile prototype based on that research.

Expected Results

- A working mobile technology that is based on the results of that research.

Technology

- Cell phones
- Software needed for the field work and the training for rural literacy instructors

Sustainability

- CONAFE offers the infrastructure for the educational centers, as well as the educational content
- ITESM searches for alliances and advisory for better educational practices, as well as the participation of the community itself, through parent associations

Instituto Tecnológico y de Estudios Superiores de Monterrey

- The Tecnológico de Monterrey was founded in 1943 as a private university. Through an emphasis in high technology, it offers traditional academic programs, continual learning for professionals, NGOs and public administrators, programs for teachers of lower and middle school, as well as instruction for the development of rural environments

Environment and Community

Team Advisors:

Rich Fletcher

Mobile Phones for Disaster Management and Risk Reduction

Catholic Relief Services (CRS) India

CATHOLIC RELIEF SERVICES

Disaster Context

- India has been suffering over US$ 1B/yr in disaster-related losses during the past 20 yrs
- From 1990-2000
  - an average of 4,344 people lost their lives each year
  - about 30 million people were directly affected by disasters each year
  - and 3 times as many indirectly affected
- Natural Hazards:
  - Flood, cyclone, drought and earthquake
- 80% of India's land mass vulnerable to at least one hazard
- 22 out of 28 states are multi-hazard

CRS
CATHOLIC RELIEF SERVICES

Disaster Context

Figure by MIT OpenCourseWare.

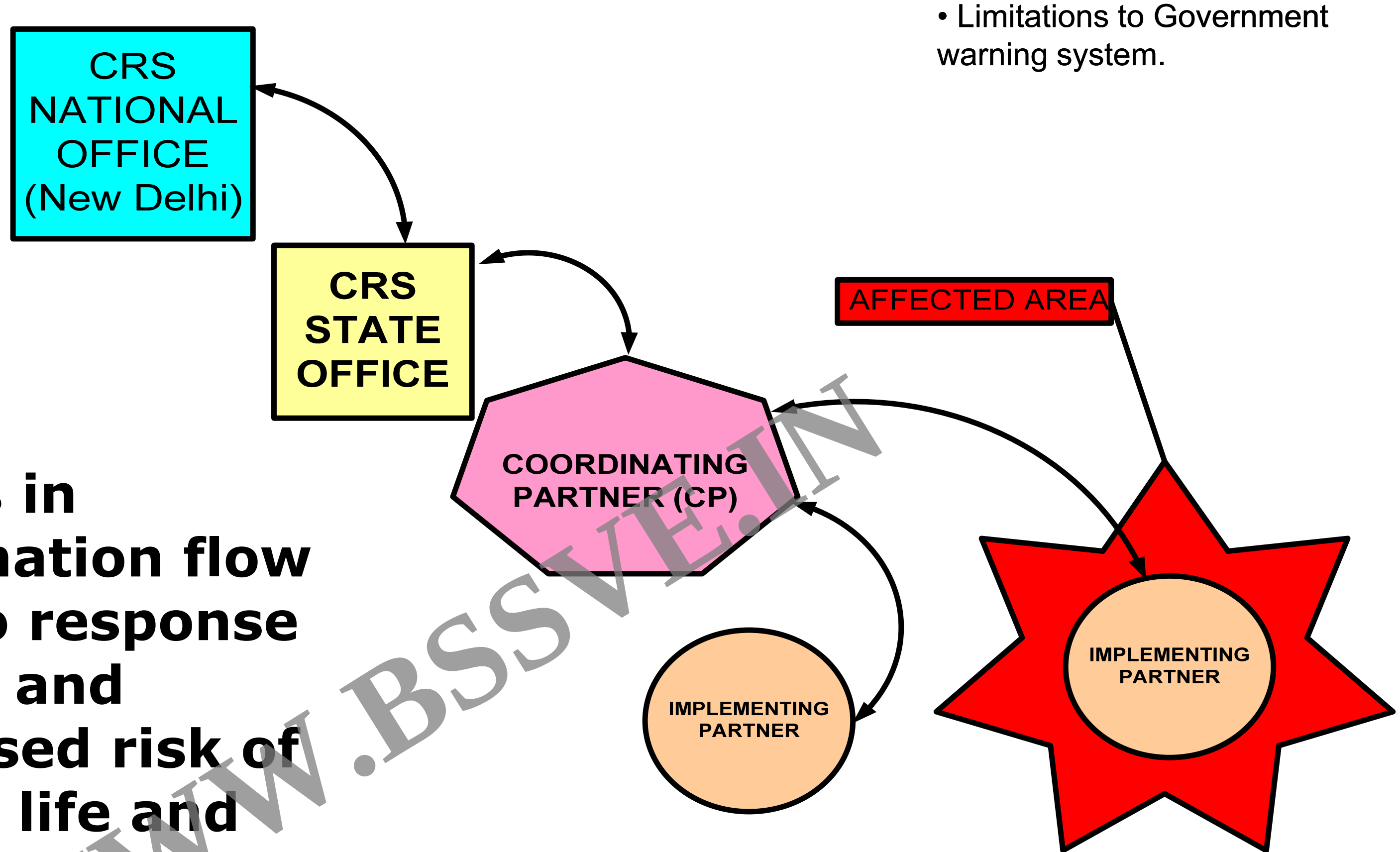
MIT

Project Proposals

The problem…

• Traditional EW system suffers from low reach and high transmission loss

• Limitations to Government early warning system.



Delays in Information flow lead to response delays and increased risk of loss of life and livelihoods.

CATHOLIC RELIEF SERVICES

Expected Results, Impact on Community

- This pilot expects to provide a replicable model –
  - To improve access to timely and accurate information for all stakeholders to inform decision making.
  - To support early warning systems (EWS) in providing timely information (from government and media) to communities in vulnerable locations for safe evacuation.
  - To support follow up monitoring of disaster situation and interventions to inform required changes based on feedbacks.
  - To map out hazards hit areas (or prone locations)
  - Locating relief camps, health camps, available services

The technology is expected to increase the efficiency and speed in delivery of information, data and relief services both before and following a natural disaster.

Technology

- Priority
  - collection of rapid assessment (and other) forms via mobile
  - reporting via web to CRS and partner offices
  - provide early warning on a potential hazard to the communities in vulnerable locations

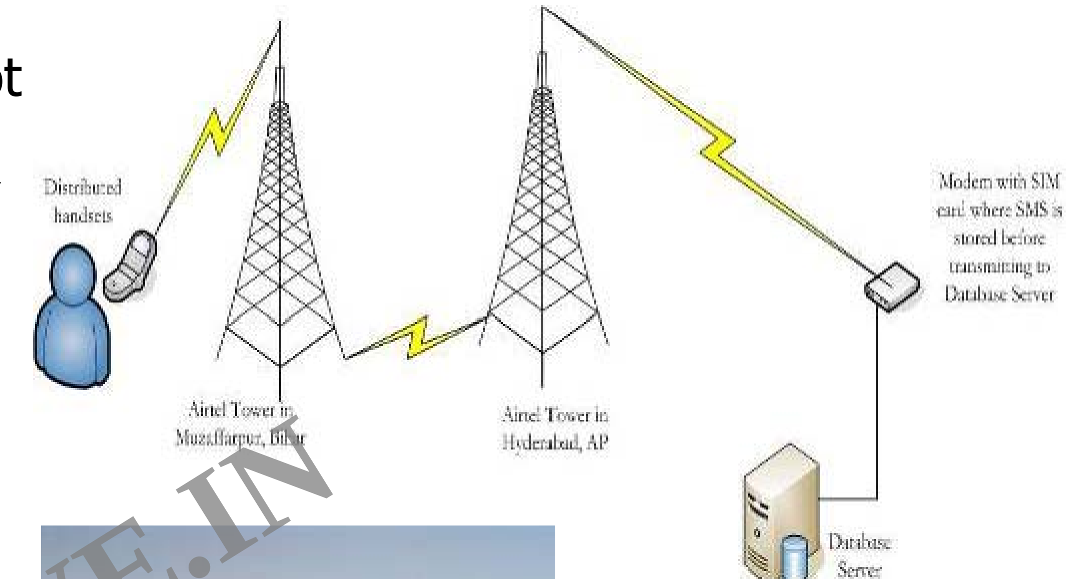
- Possible Extra Features
  - Multimedia reporting (e.g., pictures of disaster sites)
  - Use of Location info (e.g., via GPS)
  - Do more than just data collection
    - data access, computational tools, etc

CATHOLIC RELIEF SERVICES

Technical Challenges During the Pilot, Phase – I

- Problem: the gateway was not able to handle bulk SMS messages and would abruptly stop responding
- The design was not able to capture lost SMS, SMS delivery acknowledgement was having problems

The current pilot (Phase – II) is expected to take in to account of the lessons learned from the Phase - I



How is the Project Sustainable?

- The proposed technology is a low cost and community will be able to maintain with minimum inputs.
- Potential to link the communities with government early warning information sources.
- The existing infrastructures and capacities (from the first phase pilot) can be used.
- In hazard prone communities, at least one household has a mobile. So, system is not new to the communities/participants.
- There are opportunities for collaboration with government and private network providers.

CATHOLIC RELIEF SERVICES

Organization and Role

- CRS has been in India since 1946
  - one of 99 CRS country programs worldwide
- CRS supports a network of local partners
  - Indian NGOs, both faith and non-faith based
  - 2,400+ Operating Partner Organizations (Ops)
- Main Programming Areas:
  - Disaster Management, HIV, Livelihoods Security, Woman and Child Protection and Health
- More than 1.5 M program beneficiaries/year
- CRS and implementing partners will use their community experience to train groups
- CRS India IT and Programming Team to provide input

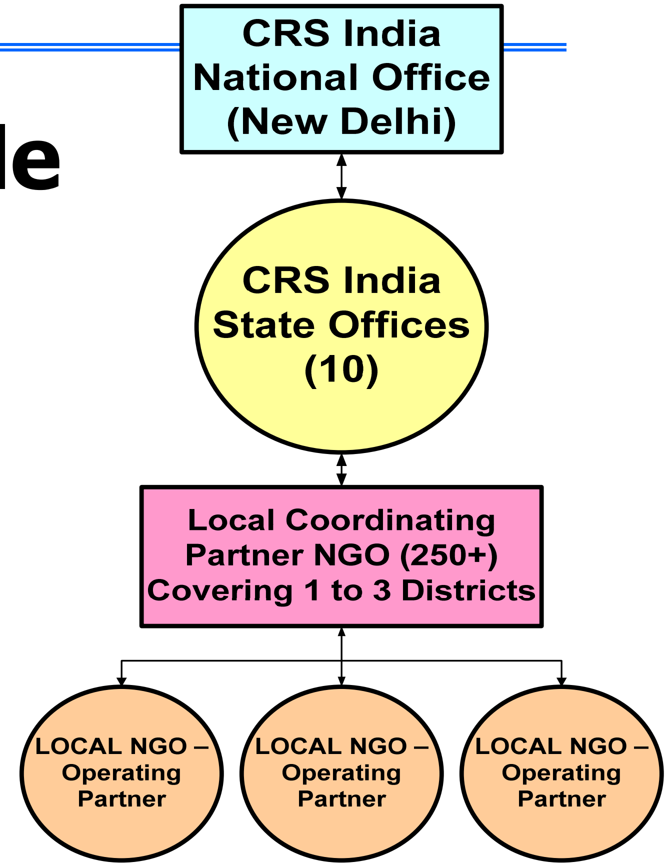


Figure by MIT OpenCourseWare.

Innovative Green Tech

Mobile Sensors and GPS Mapping for Farmers

NGO: InnovGreen, Vietnam

Sponsor: Flow Inc., Taiwan

Mobile Tech: MIT

Project Proposals

nextlab

NextLab I, F'08, L2 slide 86

Courtesy of Young Yang, Flow Inc. Used with permission.

Need or Problem Identified

Agent Orange

in Vietnam War

Rainbow Deadly Chemicals,
Over 10 Million Gallons on the Vietnam,
Destroy 6M+ acres land and 4M+ victims of Dioxin.
Source: http://en.wikipedia.org/wiki/Agent_orange;
http://en.wikipedia.org/wiki/Vietnam_war

InnovGreen are Doing

- -Clean up land mines
- -Detoxify deadly chemical
- -Fertilize land
- -Plant forest

Project Objective and Description

Objective: Mobile Environmental Sensors and Maps

Current Issues:

- **Fertilizer bags are very heavy ; thus farmers resell or dump fertilizer on the road**
- **Fertilizer costs 1/3 of total plantation cost, so cannot be wated**
- **Farmers scatter in deep mountain for 5 ~ 10 days long fertilizing trip**
- **Pay wages by every trip; but see results at least 6 ~8 months later**

Preferred Solution:

- Create Traceable & trusted fertilization using photos with GPS location
- Saving on fertilizer by doing on-site soil analysis (sensors)
- Give GPS mapping tools to scattered farmers
- Monitor and evaluate quality of fertilizing process using sensors

Expected Results, Impact on Community

Expected Results

Success in Plantation Management

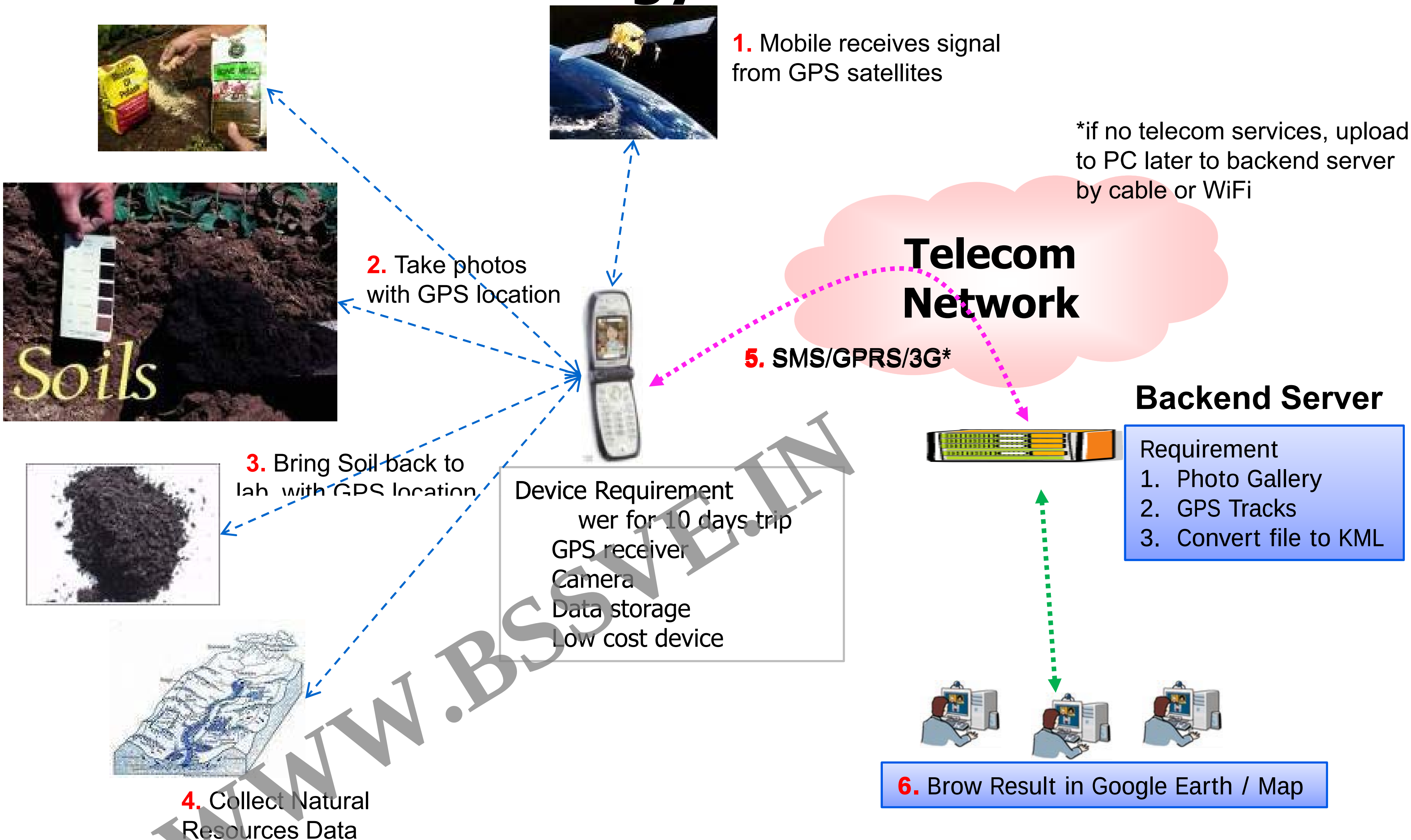
- -Control trust and traceable quality of fertilizing process by low cost tool
- -Create better managed incentives for farmers to be paid
- -Create a system to track plantation trip, route, and results
- -Collect various natural resource data such as soil, watershed, and bio-info.

Impact on Community

Success in Community & Environment

- -Establish long-term sustainable forest plantation
- -Help local farmers financially independent
- -Co-grow with local environment and community development

Technology Guidelines



Sustainability

Sustainable in Technology

-Leverage good enough technology to control quality of plantation process
-Collect and manage mass data of natural environment resources
-Scale out the same system to other area

Sustainable in Economic

-Provide incentive program to help local farmers financially independent
-Create long-term sustainable forest plantation
-Control damages from natural disasters such as flooding and landslides

Sustainable in Social

-Clean up mine, detoxify deadly chemical, and plant forest
-Co-grow with local environment and community development
-Reduce the impact of global warming, CO_2 emission and natural calamities

Work/Design Challenge – InnovGreen Team

Phase I

Design Network Architecture and Software
- Create phone interface (Windows Mobile 6)
- Create server backend – L.A.M.P. tools → Google Maps
- Create process to annotate photos with GPS info. and browse data

Phase II

Create clever onboard sensors
- Machine vision software on phone
- Software app to measure height of trees
- other simple measurements?

Phase III

Design Interface to external sensors
- Bluetooth link
- Software service to parse and format data packets

The Next Billion in Our Neighborhood

A collaboration with the City of Boston

Teams Advisor:

Luis Sarmenta

Boston Baby Blog

Countdown to Kindergarten and ReadBoston

Boston, Massachusetts, United States

Boston Needs New Tools to Reach Parents

Parent Education Campaigns
with traditional tools to reach parent population
(workshops, websites, guides, printed materials and giveaways)

Parents – low income and young parents especially – **want information through their cell phones**

Need new tools that use cell phone technology to effectively reach parents

Boston Baby Blog

Create a **Boston Baby Blog** that parents can access through their cell phones to:

- **Document and store child's growth and development** with pictures and short messages – online baby book
- **Receive information and tips** on child development and parenting using content already developed by campaigns
- **Stay informed** about upcoming events and opportunities in their neighborhood to better connect families to their communities
- **Communicate with providers** (pediatricians, child care providers, teachers) about child development and questions and concerns before any scheduled appointments to make better use of face-to-face time during visits and meetings (long term feature)

Increased Effectiveness through Technology

Boston Baby Blog will increase effectiveness of Boston's parent education campaigns, by

- Allowing campaigns to **communicate directly with parents on a regular basis** – reminders about activities, tips, events
- Providing parents with **age-appropriate information** about their child – all based on a child's birth date
- Reaching out to **"at-risk" low-income and younger parents** with technology they have access to and are comfortable with
- Reaching out to **non-English speaking parents** in their own language without the expense of printing new materials

Technology Guidelines

- **Simple and Accessible** – easy to use by both staff and parents
- **Automatic** – built in updates that parents receive automatically when their child reaches new development stages
- **Scalable** – need the ability to communicate with increasing numbers of parents over time – from 300 to 10,000
- **Secure** – need the ability to securely store individual child development information, particularly to meet long-term goal of improved communication with providers
- **Easy to Upgrade** – need the ability to layer on additional features over time
- **Low Cost** – limited resources for technology at Countdown and ReadBoston

Boston Baby Blog's Sustainability

- **Countdown and ReadBoston** are both stable, respected organizations in Boston with strong connections to parents and communities
  - Full-time **staff and resources** dedicated to implementing parent education campaigns
  - Will be able to **build on the Boston Baby Blog** over time with new information and resources from future campaigns
- **Thrive in 5**, new city-wide framework to support school readiness, will bring together other partners and providers who will expand use of the service and suggest additional features to add in over time
- **Baby Blog could be a marketable product/service** for family support and engagement organizations to increase their capacity to communicate with families

Partner Organizations/Project Managers

ReadBoston – Early Words

ReadBoston provides services through early childhood programs, schools, after school programs and other community-based partners to achieve the goal of having all children in Boston reading on grade level by the time they complete third grade.

Countdown to Kindergarten – Talk, Read, Play

Countdown to Kindergarten engages families, educators and the community in a citywide effort to enhance early learning opportunities and to support the transition into kindergarten.

Thrive in 5

Boston's city-wide framework to prevent the achievement gap in our next generation by promoting school readiness and ensuring healthy development of Boston's youngest children

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Fall 2008

Needs Assessment Procedures: Combining Quantitative and Qualitative Research for Development Projects

Rachel Hall-Clifford, PhD, MPH, MSc
Boston University, Dept. of Anthropology
rahall@bu.edu

MIT: ICT4D
10 September2008

Why we need 'Needs Assessment'

1. Who generated your idea and why?
   Technologically interesting? Perceived need?
2. Does your target population **NEED** your product or intervention? Who determines this?
3. Does your target population **WANT** your product?
4. How open are you to changing your idea or product to correspond with local input?

Doing Your (Market) Research

- **Qualitative Methods**
  - Key informant interviews

    Public officials, business leaders, members of the community, etc.
  - Focus group discussions
- **Quantitative Methods**
  - Survey instruments
  - Review of public records

    Health system, utilities, etc.

Conducting Focus Groups

- Constructed vs. Existing Groups
- Size matters: 8-10 is ideal
  - Fewer than 6 too small; larger than 12 too large
- Construct a series of open-ended questions on your topic
- Use probes to direct conversation
- You need at least 2 people to conduct a focus group
  - Facilitator, Notetaker (2 Notetakers if not voice-recording)
- **Use focus groups to refine questions for survey**

Example of
Focus Group Guidelines

Welcome! Today we are going to have a discussion on childhood diarrhea and its treatments. It will last approximately one hour. We hope that the results of this study will be used to improve health services in your community. If you are willing to participate, please sign the separate consent form.

1) What do you consider to be diarrhea in children?
   Prompts: frequency, consistency of stool

2) Is childhood diarrhea a problem in your community?

3) How often do children in your community have diarrhea?
   Prompts: rainy season vs. dry season, stage of development/age of child

4) What do people in your community do when a child has diarrhea?
   Prompts: types/amounts of food given, sources of advice, treatments

5) Have you ever heard of oral rehydration therapy (ORT)?
   Prompts: local brand names and providers

…

Survey Instrument Design

- What pieces of info are essential?
- Sequence questions
  - Leave most sensitive questions toward the end
  - If a question is sensitive and you don't really need it, toss it out (i.e. – income level, etc.)
- **Translation** and **Back-translation** of the survey instrument
- Calculate necessary sample size
  - See EpiInfo at www.cdc.gov for sample size calculator
- **Pre-test**
  - Check for wording, appropriateness, and interest

Sample of a Survey Instrument

- Make a spot for interview ID
- Introduction
- Staging of questions, from general to specifics about your topic
- Don't collect more demographic data than you need

Participant ID __ __ __ __ __ __
Date __ __ / __ __ / __ __
Delivered/Received by_______

Introduction

Hello. We are part of a study on the factors influencing the choice of treatment for diarrhea in your community. We hope that the results of this study will be used to improve health services in your community. If you are willing to participate, please sign the separate consent form and complete the following survey. All information you share will be kept strictly confidential. You are not required to answer any questions that you do not wish to answer.

Information about YOU

1) What is your age? _______ years 2) Are you MALE or FEMALE? (Circle your answer.)

3) How many years of education have you completed? _______ years

4) What is your employment status? (Circle the response(s) that best describes your situation.)
a. Unemployed
b. Student
c. Full-time formal employment
d. Part-time formal employment
e. Full-time informal employment
f. Part-time informal employment
g. Disabled

5) Number of people in your household?

________ children ________ adults

6) What is your marital status? (Circle the response that best describes your situation.)
a. Never married
b. Committed partner
c. Married
d. Separated
e. Divorced
f. Widowed

7a) Do you have children? (Circle your answer.)
a. YES (Answer question 7b.)
b. NO (Proceed to question 8.)

7b) If yes, Number of livebirths _______

Number of living children ________ Ages of living children ________

- Keep it as brief as possible
- Leave space for open-ended comments

Information about YOUR COMMUNITY

8) How would you define diarrhea?____

9) Do you think that diarrhea is a problem for children in your community? (Circle your answer.)
   a. YES
   b. NO

10) Do you know anyone in your community who has lost a child to illness after diarrhea?
   a. YES
   b. NO

11) Do you treat diarrhea with any medicines or procedures?
   a. YES
   b. NO

12) Where in your community is a good place to go for treatment of diarrhea? (Circle all that apply.)
   a. Relative or friend
   b. Pharmacy
   c. Local healer
   d. Health post/clinic
   e. Other:______________________

Information about Oral Rehydration Therapy

13) Have you heard of oral rehydration therapy(ORT)? (Circle your answer.)
   a. YES (If yes, PLEASE ANSWER QUESTIONS 14 through 17.)
   b. NO (If no, PROCEED TO QUESTION 17.)

14a) Are you aware of anywhere in your community that offers oral rehydration therapy?
   a. YES
   b. NO

14b) If yes, Where is ORT available? (Please list all locations.)

____

15) Have you ever used ORT to treat a child with diarrhea?
   a. YES
   b. NO

16) Is ORT good for diarrhea?
   a. YES
   b. NO

17) Do you have any comments about this survey or diarrhea treatment? (Please write below.)

Survey Development:
Questions to answer in your groups

1. **Who is your target population for survey?**
   - Health staff, educators, community members
   - Estimate of the size of the population for sampling
2. **What demographic data would you need?**
3. **What infrastructure (physical and human) information would help you design your project/product?**
   - Technical skills, availability of electricity, current practices
4. **What beliefs, opinions, and practices would affect utilization of your project/product?**

Further Resources

- Scrimshaw, Nevin S., Gary R. Gleason, R*apid assessment procedures: Qualitative methodologies for planning and evaluation of health related programmes,*1992 http://www.unu.edu/unupress/food2/UIN08E/UIN08E00.HTM
- Pertti J. Pelto and Gretel H. Pelto, *Studying Knowledge, Culture, and Behavior in Applied Medical Anthropology*, Medical Anthropology Quarterly, New Series, Vol. 11, No. 2, Knowledge and Practice in International Health. (Jun., 1997), pp. 147-163. http://links.jstor.org/sici?sici=0745-5194(199706)2%3A11%3A2%3C147%3ASKCABI%3E2.0.CO%3B2-A
- Corlien M. Varkevisser, Indra Pathmanathan and Ann Templeton Brownlee, *Designing and Conducting Health Systems Research Projects*. http://www.idrc.ca/en/ev-33011-201-1-DO_TOPIC.html
- Patricia M. Hudelson, *Qualitative research for health programmes*, World Health Organization. Division of Mental Health. WHO Doc No.: WHO/MNH/PSF/94.3. http://whqlibdoc.who.int/hq/1994/WHO_MNH_PSF_94.3.pdf
- The HIPAA rules: http://www.hhs.gov/ocr/hipaa/ http://physionet.org/physiotools/deid/doc/deid-paper.pdf see table 1, page 48
- Guidelines for Informed Consent Forms:
  - http://web.mit.edu/committees/couhes/informedconsent.shtml *Provides template forms
  - http://ohsr.od.nih.gov/info/sheet6.html
  - http://www.samford.edu/IRB/ic_examples.html

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Fall 2008

Team Formation

Projects Selected by Class

A. **Giving Farmers a Fighting Chance (Monterrey Tec)**
B. **Mobile social network for students in low-income communities (Telmex)**
C. **Thrive in Five Baby Blog (Boston Mayor's Office)**
D. **Mobile diagnostics (CIDRZ, GE Healthcare)**
E. **Multilevel marketing for microfinance (COBIS)**
F. **Disaster Management + Mobile Sensors and GPS Mapping (CRS + InnovGreen)**
G. **M-commerce interface (United Villages)**

Team Formation

- These are small teams, each member puts multiple “hats” on. All workload must be equally distributed.

- However, each team member will be designated to log team accountability of:
  - Operation matters (MIT)
  - Sustainability matters (MIT)
  - Software Development matters (MIT)
  - Systems Architecture matters (MIT)
  - Media and Communications matters (Emerson)

Contacting your Project Partners

- **We will notify Project Partners of your selections, and will get them ready to be contacted**
  - **Contacts should start no earlier than tomorrow**
- **Next Steps:**
  - **Meet your Team Advisors and map out a formal strategy for interacting with your Project Partners**
  - **Team Advisors will give you contact data and any more information that we have on projects**
- **Please make sure your communications with them are ORDERLY and CONSISTENT, as they have many other things to attend**

Milestones

Milestones

1. **Elevator Pitch and Related Work (Sept. 24)**
2. **Needs Assessments Initial Results (Oct. 8)**
3. **System Design, and Initial Implementation Results (Oct. 22)**
4. **Sustainability / Financial Factors (Nov. 5)**
5. **Feature Complete (Nov. 19), General Progress Report**
6. **Working Demo (Dec. 1)**
7. **Final Presentation Event (Dec. 10)**

Elevator Pitch

- ________
  is a ___________________
- for
  ____
- that, unlike
  __________________,
- ________________________

- This is good to have so that:
  - you know what you're doing
  - you can easily explain it to others

Elevator Pitch

- <name>
  is a <service / app / device / platform / ?>
- for
  <purpose, problem that it solves>
- that, unlike
  <alternatives, current way it's done>,
- <what it does differently>

- This is good to have so that:
  – you know what you're doing
  – you can easily explain it to others

Solutions and Related Work

- **The Present Solution**
  - **How are things done now?**
  - **What is wrong with that?**
- **Alternative Solutions / Related Work**
  - **Has anyone else come up with a better solution?**
  - **Has anyone done something not directly related that may be useful?**
- **Your solution (what can you do)**
  - **Just use existing solutions and put them together**
  - **Modify / extend existing solutions**
  - **How?**

Milestone #1 (Sept. 24)

- **Present your elevator pitch (1 minute)**
- **Present Solutions and Related Work**
- **What you need to do to prepare**
  - **talk to your project partner to get context, purpose, and current solution (start now!)**
    - **this is also a form of Needs Assessment**
  - **do background research on existing/related solutions**
  - **write-up your proposed improvement**

Milestone #2 (Oct. 8)

- **Present Needs Assessment and Feedback results from partner**
  - **What does your partner think about your proposed solution?**
  - **Does it fit their needs?**
  - **How does this affect your plans?**
- **What you need to do to prepare:**
  - **present your Milestone #1 report to your project partner (on Sept. 24, regardless of whether your are called)**
  - **Get their feedback**
  - **Think about how it affects your proposal / plans**

Milestone #3 (Oct. 20)

- **System Design and Initial Implementation Results**
  - **How are you going to achieve your goal?**
  - **What are the components of the system?**
    - **block diagram**
  - **How is it used?**
    - **users and interface to users**
  - **How does it work?**
    - **what happens in different use cases**
    - **what data moves where?**
    - **what computation needs to happen?**
  - **Any potential difficulties?**
    - **e.g., certain assumed functionality not being available**
  - **Progress report on initial implementation**
- **Start working on this asap (Sept. 24 or even before)**

Readings

Readings

- **See readings in the syllabus**
- **Pick a paper to present to class**
  - **Pick one you are personally interested, and may have experience in**
  - **You should**
    - **Summarize the paper for everyone in class**
    - **Give your own input. Feel free to relate it to other papers / articles / or personal experience**
- **Put your name next to the paper in the online survey.**
  - **It will be online 7pm today. First come, first serve.**
- **Be ready to present on your designated date**

MIT OpenCourseWare
http://ocw.mit.edu

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Class Logistics, Milestones, Readings, etc.

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E. Multilevel marketing for microfinance (COBIS)
F. Disaster Management + Mobile Sensors and GPS Mapping (CRS + InnovGreen)
G. M-commerce interface (United Villages)

Team Consolidation

- New Students in Class
  - Check skills and background
  - Team Designation
- Early Casualties
  - Each person check if your team is complete
  - Speak up if not complete or people wiggling
- Logistics
  - First meeting with Advisors?
  - Planned a contact strategy with Project Partner?
  - Planned Milestone completion schedule?

Team Formation

- These are small teams, each member puts multiple "hats" on. All workload must be equally distributed.

- However, each team member will be designated to log team accountability of:
  - Operation matters (MIT)
  - Sustainability matters (MIT)
  - Software Development matters (MIT)
  - System / "Product" Design and User Experience matters (MIT)
  - Media and Communications matters (Emerson)

What NextLab is About (and What it is Not…)

NextLab is About

- Addressing a real concern stemming from the grassroots of the developing world
- Learning the many barriers of doing so; and tolerance for uncertainty and setbacks
- Holding judgment and just learning what it's like out there for billions of people
- Sensitizing yourself as to the possibilities of helping the developing world (a little) using ICTs

NextLab is Not About

- You
- Tech Prowess
- Fitting this class into a given career design
- A grade

Media Component

Keeping in Mind

- Communications officers as an integral part of the team
  - Include them in all meetings and communications; their role is as important as yours is
  - They will create a video of your technology. That is part of the grade (Public Presentation deliverable)
- Wear your NextLab gear on camera
  - It helps the cause!
  - We will give you more as the semester progresses
- NextLab t-shirt
  - Who does not have one (email me your name/size)
  - Who's got a really wrong size? (ibid)

Readings

Readings

- **10 Minute Powerpoint presentation**

1. **6-8 minutes synopsis of paper**
   – Distill the most salient and important points
2. **Personal Commentary**
   – Your own critique
   – Share personal experiences
   – Express your own opinions
   – Compare with related work you might know of
   – Etc.
3. **List of questions for class to think about and discuss**

Be prepared to help facilitate class discussion

Guided Design Process

Logistics

- There is a Milestone (out of 6) to report on every other Wednesday, starting September 24th .
  - Each Wednesday, Instructors will randomly pick 3 or 4 teams (out of 7) to present their Milestone progress to the class
  - To observe the individual performance of each member, only one person will present a given Milestone. Presentations are 10 mins long
  - Immediately following the presentation, Instructors will randomly call on audience members to give constructive feedback (including critiques). Feedback period is 10 mins.
  - The teams that do not present on that Wednesday will present the following Wednesday

Ultimate Objective

- NextLab end of semester event
  - Scheduled at Bartos for December 10th, 11am-4pm
  - Poster Session
  - Demos of Working Prototypes
  - Videos of your technologies in their context (Emerson + MIT students)
  - Team presentations to a public audience
  - Lunch, Refreshments will be served

  - A wide array of personalities will be invited from the Institute and beyond
  - We will invite members of the press (NYT, etc.)

Milestones

Milestones

1. Elevator Pitch and Related Work (Sept. 24)
2. Needs Assessments Initial Results (Oct. 8)
3. System Design, and Initial Implementation Results (Oct. 22)
4. Sustainability / Financial Factors (Nov. 5)
5. Feature Complete (Nov. 19), General Progress Report
6. Working Demo (Dec. 1)
7. Final Presentation Event (Dec. 10)

Elevator Pitch

- ________ is a ____________________
- for ________________________
- that, unlike ___________________,
- ________________________

- This is good to have so that:
  - you know what you're doing
  - you can easily explain it to others

* from Hal Abelson's class

Elevator Pitch

- <name>
  is a <service / app / device / platform / ?>
- for
  <purpose, problem that it solves>
- that, unlike
  <alternatives, current way it's done>,
- <what it does differently>

- This is good to have so that:
  – you know what you're doing
  – you can easily explain it to others

* from Hal Abelson's class

NextLab I, F'08, L1 slide 4

Solutions and Related Work

- The Present Solution
  – How are things done now?
  – What is wrong with that?
- Alternative Solutions / Related Work
  – Has anyone else come up with a better solution?
  – Has anyone done something not directly related that may be useful?
- Your solution (what can you do)
  – Just use existing solutions and put them together
  – Modify / extend existing solutions
  – How?

Milestone #1 (Sept. 24)

- Present your elevator pitch (1 minute)
- Present Solutions and Related Work
- What you need to do to prepare
  - talk to your project partner to get context, purpose, and current solution (start now!)
    - this is also a form of Needs Assessment
  - do background research on existing/related solutions
  - write-up your proposed improvement

Milestone #2 (Oct. 8)

- Present Needs Assessment and Feedback results from partner
  - What does your partner think about your proposed solution?
  - Does it fit their needs?
  - How does this affect your plans?
- What you need to do to prepare:
  - present your Milestone #1 report to your project partner (on Sept. 24, regardless of whether your are called)
  - Get their feedback
  - Think about how it affects your proposal / plans

Milestone #3 (Oct. 20)

- System Design and Initial Implementation Results
  - How are you going to achieve your goal?
  - What are the components of the system?
    - block diagram
  - How is it used?
    - users and interface to users
  - How does it work?
    - what happens in different use cases
    - what data moves where?
    - what computation needs to happen?
  - Any potential difficulties?
    - e.g., certain assumed functionality not being available
  - Progress report on initial implementation
- Start working on this asap (Sept. 24 or even before)s

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Readings and Discussion

Michael Gordon
MIT CSAIL

Agenda

Richard Heeks, "ICT4D 2.0: The Next Phase of Applying ICT for International Development," Computer, vol. 41, Jun. 2008, pp. 26-33.

J. Donner et al., "Stages of Design in Technology for Global Development," Computer, vol. 41, 2008, pp. 34-41.

Agenda

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Why ICT4D?

- Moral argument (diminishing returns for first-world technology)
- "Enlightened" Self-interest
  - "Problem of the poor today can become our problems tomorrow"
  - New markets (poor as consumers)
    - The poor have disposable income and they prioritize ICT
- "Personal" self-interest
  - Projects are interesting and satisfying

The History of ICT4D: ICT4D 0.0

- Until 1990 computing for development focused on:
  - IT for internal government administration
  - Corporations viewed IT as a tool for delivering economic growth in the private sector

- But then came the Internet and the Millennium Development Goals (1996)
  - "new tools in search of a purpose"

ICT4D 1.0: 1990s - 2000

- Era of the rural telecenter
  - Room with one or more internet-connected PCs
- Imposed existing designs and expected the poor to adapt to them

- Most ended in failure which led to new watchwords:
  - Sustainability: failed to survive
  - Scalability: limited reach
  - Evaluation: all hype

Question: What are your thoughts/experiences with rural Telecenters?

ICT4D 2.0

- Pushing the internet connected PC is difficult and recent innovations have focused on:
  - Terminals: OLPC
  - Telecommunications: wireless
  - Power: generation, storage, and consumption
- Heeks: Why push down this route when we can jump ship to a more appropriate technology: Mobiles!

Question: What are your thoughts/experiences with the OLPC?

Trends and Questions

- Incredible acceptance and growth rates of mobile telephony
- How do we reach the last "half billion"?
- Should the internet be the focus?
- What can be done with existing technologies?
  - Calls
  - SMS
  - Radios (80% penetration in DCs)
  - Televisions (50 penetration in DCs)

New Applications

- Equating poor with illiteracy is a common mistake:
  - > 50% adults in poorest countries are literate
  - 2/3 of 15 – 24 yr olds are literate
  - Villages have infomediaries
- Still need to create user interfaces appropriate for these populations
  - Audio-visual

Filling the Hardware-Interface Husk

- Content: appropriate and narrowing
  - Community radio and participatory video
- Interaction and communication
- Services
  - E-government
  - M-development: hang services on growing phone base
- Production
  - Create incomes for the poor
  - Authors of content

Approaches to ICT4D

- "Passive diffusion"
  - The market will decide if ICT4D has value
  - Combination of:
    - private firms' search for profit
    - Poor's search for value
  - Any attempt to intervene would be wasteful

- "Active innovation"
  - Market will not deliver
  - intervention required that will help meet development goals

Discussion: Comments on "passive diffusion" versus "active innovation"?

How To Innovate

- "Pro-poor"
  - Outside poor communities on their behalf
  - Design versus reality gaps
  - Some successes: pre-paid mobile plans
- "Para-poor"
  - Working alongside poor
  - Participative, user-engaged design process
  - Problems:
    - Who participates matters
  - Our class
- "Per-Poor"
  - Within and by poor community

Per-Poor

- Poor are adapting and applying technology in new ways:
  - New processes
    - Flashing
  - New business models
    - Mobile transactions of airtime
  - New products
    - Re-chipping phones (latest look without the $$$)
- My $0.02
  - Education the key to per-poor
    - Ex: MIT's EPROM and AITI

Question: Other examples of per-poor innovation?

Integrating Worldviews

- Technologists cannot stand alone
  - The problem with ICT4D 1.0
- Science and technology are climbing the development scale.
  - Korean and Taiwan (NICs)
- Integrate IS, development studies, and CS.
  - Multidisciplinary teams
- Don't trap ICT as a tool to serve individual development goals
  - Misses out on ICT's roll as a linking technology
  - Doesn't let the poor innovate

What do you think of your project and your project team?

Agenda

Richard Heeks, "ICT4D 2.0: The Next Phase of Applying ICT for International Development," Computer, vol. 41, Jun. 2008, pp. 26-33.

J. Donner et al., "Stages of Design in Technology for Global Development," Computer, vol. 41, 2008, pp. 34-41.

Stages of Design in Technology for Global Development

- Text-free UI
  - Design UI's for the 1-2 billion illiterate individuals
  - Regular UI's are text-heavy and designed for literate

Journey of design:
- Voice annotations on everything
- What do users want to know? (Job listings)
- Graphical representations (cartoons work well)
- TV and word of mouth prevailed as information channels
- Everyone could read numbers

(Indrani Medhi)

TextFree UI

- Armed with this knowledge they designed text-free monster.com and tested it.
- Only 30 percent completed the assigned task.
- The problem was not the UI:
  - Users were concerned they would break PC
  - Why use the PC? Just ask someone…
  - How did the box work?
- Solution: create a short movie that explained the *context* of the application
  - Informed by the Bollywood culture.
- After watching the video, completion rate was 100%.
  - Help build the cognitive model of the technology for the user.

Design Stages of ICT4D Projects

- Wonder: Huge problem, why does it persist?
- Exuberance: This technology will solve the world's problems!
- Realization: Discover the realities; it does not work. What are the problems?
- Adaption: Create a modified/new solution that solves the problems.
- Identification: Understand the gap between the initial and the final solution.

Example: Microfinance

- Wonder: Microfinance is great! Can we lower interest rates by lowering transaction costs?
- Exuberance:
  - Use mobile app to transfer data on a new applicant to head office. Verify data, aid in decision, update back-end database.
  - Halved per-form processing cost
- Realization: Mobile phones are expensive, after 6 years, could not recover costs.
- Adaption: Manual frontend data management linked to backend database.
- Identification:
  - Low cost of manual labor and manual data transport
  - High cost of technology

Lessons Learned

- Time in field
  - Most critical factor
  - Rapid prototyping in field: "fail early and fail often"
  - Partner with nonprofits
    - Access to target communities
    - Nonprofits are trusted by community
- Honesty about what works:
  - Does it make sense economically?
  - Have critics around (peer-review process of this class)
  - Have social scientists in the group
- Accept simple solutions!
  - Problems are sometimes not in the technology but how to get people to use it.

Discussion

- Instructors and students: Give us experiences from your past and future projects trying to fit them into the 5 stages.
- Do you think that every project will go through these 5 stages?
- What is the practical value of knowing these 5 stages?

Warana Unwired

- Wonder: 800 Million marginal farmers around world
- Exuberance: Internet for farmers brings education, telemedicine, and knowledge
- Realization:
  - Farmers unable to use internet,
  - Only used PCs to check on payment schedule and inventory
  - High maintenance costs
- Adaptation: Replace computer with cell phone, SMS-based inventory query
- Identification: PC solution was overkill and costly

Outline

Richard Heeks, "ICT4D 2.0: The Next Phase of Applying ICT for International Development," Computer, vol. 41, Jun. 2008, pp. 26-33.

J. Donner et al., "Stages of Design in Technology for Global Development," Computer, vol. 41, 2008, pp. 34-41.

A. Pentland, R. Fletcher, and A. Hasson, "DakNet: rethinking connectivity in developing nations," Computer, vol. 37, 2004, pp. 78-83.

DakNet: Rethinking Connectivity in Developing Nations

- Researchers unsatisfied with ICT4D 1.0 projects
  - Telephones for every villages
    - "Who am I going to call?"
    - Landlines are expensive
- What about wireless technology?
  - High bandwidth
  - Ease of setup and use
  - Much cheaper than copper phone lines
    - Cheap commodity equipment
  - DNs can leapfrog over wireline telephony

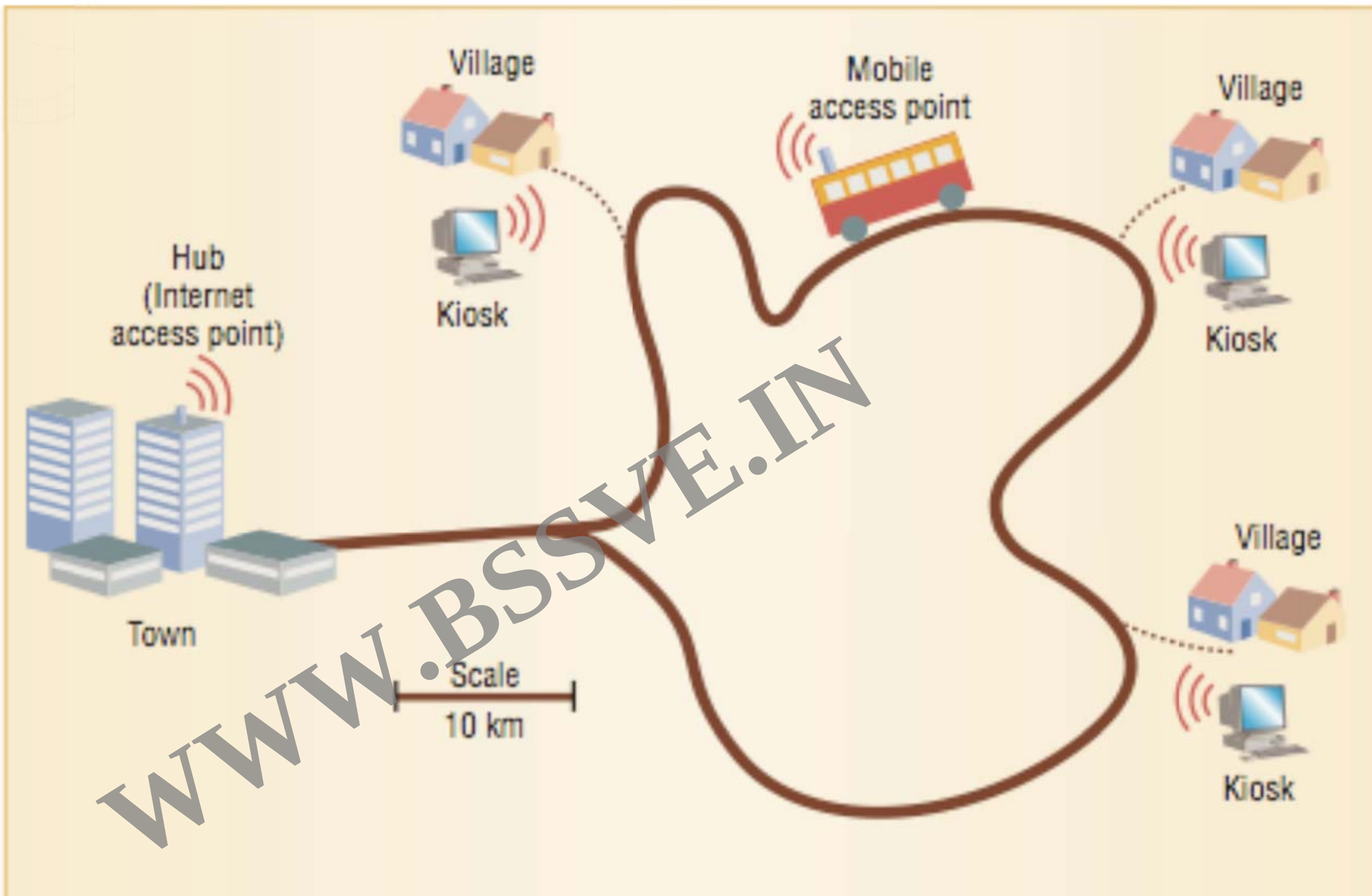
Insights: Asynchronous Communication

- Voice communication is synchronous
  - Both parties on the line at the same time
  - Disadvantage when using shared phones
  - Expensive (landlines)
- Asynchronous communication is popular in the developed world
  - Email
  - Voicemail
  - SMS
- Cost effective starting point for rural connectivity

Insights: Services

- Villagers are willing to pay for digital services.
- Save them the time and much higher costs of poor transportation
- For government services, digital access could reduce corruption and unfair pricing.
- Start with a basic (seed) service and see how technology can support or streamline the service

DakNet – Mechanical Backhaul



From Pentland, Fletcher, and Hassan. "DakNet: Rethinking Connectivity in Developing Nations." *IEEE Computer* 37, no. 1 (2004): 78-83. Copyright © 2004 IEEE. Used with permission.

Example: Bhoomi Initiative in India

- Initiative to computerize land records
  - Kiosks set up in towns
  - Bus serves land records

- Costs (2004):
  - $580 for MAP bus (computer, amp, power supply)
  - $185 for village kiosk
  - 10 Villages = $243 per village

Discussion

- Will DakNet still have value as more villages get mobile service?
- What other services could be rolled-out using DakNet's model?

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Information (Technology), Market Performance, and Welfare in The South Indian Fisheries Sector

NextLab I Reading Presentation

09/17/2008

Executive Summary

- Does ICT really matter (has a priority) in low income countries?
- Use introduction of mobile phone into Southern India as evidence
  - A close study from 1997 to 2001
  - Proving economic models and theories (90% of the paper)
- Result confirmed improvement in market performance and citizen welfare

Study conducted in Southern India
Kozhikode, Kannur, and Kasaragod

Figure by MIT OpenCourseWare, using base map by US CIA.

- Heavy fisheries area
- 15 markets 15 miles apart
- 300 sardine fishing units
- One market sell per day
- Introduction of mobile phone in 1997 to 2000

The Economics Model predicts market performance and welfare improvement

- Information enables sellers decision to not sell on local market
  - High VS. low density of fish zones
- Model and theorem based on Bayes-Nash equilibrium game theory
- Linear regression predicting the effect

Results matches predictions

- Lower in overall fish price (4% lower)
- Lower price dispersion within and between markets (from 70% to 15%)
- Eliminate waste (from 5-8%)
- Consumer and producer surplus increase

Alternative explanations are disproved

- Explanations such as:
  - Mobile phones lead to increase in wealth in those area of coverage
  - Mobile phones effect transaction timing and create collusion
  - Entry and exit changes overtime

Summary

- ICT adds benefit to low-income region by generating a well functioning market and should be prioritize
- Practice can be repeated elsewhere especially in perishable commodities sector
- Information available from ICT development enforce economic theorem
  - Law of One Price
  - Welfare Effect

MIT OpenCourseWare
http://ocw.mit.edu

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THE ECONOMIC LIVES OF THE POOR

Abhijit V. Banerjee & Esther Duflo

Abdul Latif Jameel Poverty Action Lab

MIT

Sreya Sengupta

NextLab

September 17, 2008

13 Countries Surveyed

- Cote d'Ivoire
- Guatemala
- India
- Indonesia
- Mexico
- Nicaragua
- Pakistan
- Panama
- Papua New Guinea
- Peru
- South Africa
- Tanzania
- Timor Leste

What is poor?

- According to the World Bank's 1990 World Development Report…
  - "extremely poor"= Less than $1 per day (1993 PPP)
  - "poor"= Less than $2 per day

Family Size

- Tends to be rather large by today's standards
  - Varies between 6 and 12
  - Median value between 7 and 8
- Common for adults to live with extended family
  - Parents, siblings, uncles, cousins, etc.
- Population is relatively young
  - Higher mortality rates, older=richer?

Food and…

- Food represents 56 to 78 percent for rural households, and 56 to 74 for urban households
- The rest?
  - Alcohol and tobacco (4.1% in PNG, 5% in India, 6% in Indonesia, 8.1% in Mexico)
  - Entertainment (50 to +99% spent on weddings, funerals, religious festivals)

Food and…

- The poor see themselves as having a significant amount of choice and choose not to spend more on food
- Up to 30% more could be spent on food
- 1% increase in expenditure = .67% increase in food
- Nutritional value: opting for more expensive, less calorie-rich items

Asset Ownership

- Land
  - Small plots of dry scrubland that cannot be cultivated for most of the year
- Few durable goods (ex. automobiles, appliances, manufacturing equipment)
- Self-owned businesses with no productive assets

Health

- Average poor person consumes less than 1400 calories per day (half of what the Indian govt. recommends)
- 65% of men and 40% of women have a BMI below 18.5
- Anemia, diarrhea
- Self-reported happiness not particularly low
- Poor households bear most health care risks
- Low quality of free health care provided by government

Education

- Extremely poor spend very little on education
  - Public school (93.4% in India)
  - Avg. absence rate of teachers is 19%, 35% for health care workers
- Low quality
  - 35% of kids 7-14 cannot read at 2nd-grade level
  - 41% cannot do subtraction, 65% cannot do division

How the poor earn $$$

- Entrepreneurship
- Multiple occupations
  - The median family had 3 working members and 7 occupations (W. Bengal)
- Lack of specialization
  - Some agriculture, short-term migrants
  - Trading off opportunities to have higher incomes

Savings

- Few poor households have savings accounts
- Savings "clubs"

Credit Markets

- Very few poor households get loans from formal source (ex. commercial bank, cooperative)
- Majority of the 2/3 of people who had loans received them from relatives, money lender or shopkeeper
- Informal lending more expensive (less from credit defaults than contract enforcement)
  - Less capitalized, less regulated, no government guarantees, higher cost of deposits

Questions

- Why so little specialization?
  - Risk spreading
  - Occupy otherwise wasted time
  - Poor cannot raise the capital necessary to run full-time business; very little assets & limited working capital
- Why so many entrepreneurs?
  - W/ few skills and little capital, easier than finding a job

Questions

- **Why don't the poor eat more?**
  - **Eating more wouldn't help that much in preventing weakness to disease.**
  - **Save $$$ on eating today in order to spend more on entertainment tomorrow.**
- **Why don't the poor invest more in education?**
  - **Poor parents may not recognize that children aren't learning.**
  - **Private school teacher are usually less qualified.**

Questions

- Why don't the poor save more?
  - Saving at home is hard, constantly resisting temptation to spend.
- Why don't the poor migrate for longer? (given that they could easily make more money that way)
  - Remaining close to social network
  - Making more $$$ not a huge priority

MIT OpenCourseWare
http://ocw.mit.edu

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Cultural and Social Factors Influencing Mortality Levels in Developing Countries – John C. Caldwell

Jon Varsanik
Nextlab Fall 2008
9/28/08

Overview of Paper

- Collection of several surveys
- Use them to explain global mortality transition
- Analyze how social factors affect death rates

- Thesis:
  - Social factors or cultural characteristics are more influential in determining mortality levels than is access to medical services, income, or nutritional levels

Ten social factor studies

- Halstead, Walsh, Warren
  - NOT income or level of health services
- Flegg
  - Literacy – low infant mortality
  - Equality of income, and level of medical care
- Caldwell
  - Proportion of females in school a generation earlier
  - Also, family planning and male school attendance
- Rodgers and Wofford
  - Literacy, proportion of population working outside of agriculture
- Gaisie
  - Mother education
- Behm
  - Mother education
- World Fertility Survey (2 separate analyses)
  - Parental education
  - Also, income (evidenced by father's occupation)
- Mensch, Lentzer and Preston (analyzed 15 surveys)
  - Mothers education, ethnicity, and father's education in urban areas
- Orubuloye and Caldwell
  - Mother's education – controlled for occupation of parents, urban/rural, family structure, family planning
- Cleland and Ginneken
  - Mother's education – only half of effect is due to the material advantages associated with mother education

Cultural factors studies

- DaVanzo, Butz, Habicht
  - Ethnic groups
- World Fertility Surveys
- Indian Sample Registration Survey and International Diarrhoeal Diseases Research Center data
- Changing African Family Project
- One-per-Thousand Survey of China

Cultural factors

- "…persistent, but under-researched, finding is that there are major ethnic or cultural differentials in mortality… - differences that survive controlling for income and education."
- "…societies are largely prisoners of their cultures and histories and that the roots of contemporary health successes lie far back in those histories."
- Reasons
  - Preference for sons over daughters
    - Girls neglected, get less share of limited resources
  - Family planning

Measurements

- Infant mortality
  - ¼ of all births result in deaths before 5 years of age.
  - Due to age structure f population, half of all deaths in the society occur to persons under 5 years.
  - Also, more controlled data?
- Years of education
  - Easy to quantify
  - Related to other cultural factors that are harder to measure

Social Factors Explanations

- Education
  - Two impacts:
    - Changing behavior of individuals
    - Changing society
- Educated Mothers
  - More effective in gaining resources form their husbands
  - More likely to be the one to detect that their child is sick.
  - More likely to adopt effective home action when there is a sickness
    - Home care accounts for at least half of all treatment in the Third World
  - Spend more time with the doctor giving child's history
  - More likely to carry out doctor's instructions properly
  - More likely to go back to the doctor if the condition does not improve

Compares to development of Western cultures.

- Turn of the century in the US, was sharp decline in mortality rate
  - Industrial revolution
  - Higher real incomes
  - Improved healthcare, hospitals.
- Gap in US in 1900 between educated and uneducated classes was smaller than in contemporary Third World.
  - Because behavioral pattern was still similar between classes.
- Reasons for mortality declines in Third World are different than those of the US.
  - Health-friendly social norms were already being spread through missionaries, media, and education system.
  - Technology is there, it is access and proper use that is important

Theories for "health transformation"

- There have always been socioeconomic differentials in mortality levels.
  - Dismissed: improved efficacy of medicine – people with more access will benefit more
- Interaction with modern medicine
  - Uncontrolled spread of medicine through unauthorized sources – hardly researched
  - Dismissed: "breakthrough periods in reducing mortality levels … have been associated with the democratization of services, not increase of quality."
- All facets of the same phenomenon: "social modernization."
  - Individualism, Westernization
  - Belief that sickness is not magical, but that it is possible to do something about it. – "secularization of health behavior."

My Thoughts

- Paper is from 1990. – What has happened since?
- Mostly unorganized
- Correlation / causation?
  - Nomenclature: "indicator" vs. "influences"
  - "…may, in fact, correlate more highly because health investment has been running ahead of social investment in terms of the optimum mix."
  - Other factors involved with education?
  - I guess that is his point.

Questions

Backups

One Example: Halstead, Walsh, Warren

- 4 Third World societies
- 3 had ~15 year higher life expectancies than countries with similar incomes. 3 years lower than Eastern Europe.
- Sri Lanka spends 1.2% of GNP on health (Western civilizided countries is 3.7%), and has 15 times as many people per doctor.
  - Other countries "Probably present a similar picture…"

"The conclusion is inescapable that neither income nor levels of health services… are the explanation for the remarkable health achievements of these societies."

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Design of Health Care Technologies for the Developing World

Robert A. Malkin

Definitions

- Developed World:

  Nations that the United Nations Considers to have High Human Development.

Human Development:

A numerical measure of a Nation by the UN, based on indicators as Life Expectancy, Adult Literacy and GDP (Gross Domestic Product).

"Health for All by 2000"

- International effort
- Specific areas of need. (oral re-hydration solutions, food supplements, antibiotics, vector control agents, water pumps, latrines).
- Technology was known, effective and cheap.

Technology

- Money should be spent in other areas. (social services, basic needs).
- Out of context equipment.
- A new scanner won't change the outcome, diagnoses or the length of stay of the patient in the hospital.
- No one to repair or maintain the equipment.
- It goes only to main cities and private hospitals.

General Barriers

- Training of Staff
  – Reluctance to change
  – Language Barriers

EWH

- Engineering World Health
  - 4 year study on Medical Equipment in Developing Countries.
  - On-site equipment analysis and staff interviews.

- Interview (technical staff, doctors, nurses, and admin. staff).
  - 1st round, Basic Questions.
    - How many technical staff does the hospital have?
    - How have they been trained?
    - What is the spare parts budget and equipment budget of this hospital?
    - What % of equipment is donated?
    - What % of equipment is working?
    - What is the average age of your medical equipment?

- Interview

  – 2nd round, In depth Questions.
    - What is the most difficult technical obstacle you need to overcome in order to do your job more effectively?
    - What healthcare technology on the current market meet this need?
    - What are you currently using to solve this problem?
    - What equipment do you most need at this hospital?

Results

- Equipment Data from 33 hospitals in 10 countries.
- Interviews in additional 21 hospitals in 6 countries.

- COST
- SPARE PARTS
  - Not available in the country
  - Not available in the market.
- CONSUMABLES
  - Laboratory test strips, ECG Electrodes, electrosurgery tips, etc.

Other Barriers

- Lack of technical staff.
  - poor literacy rate.
    "Brain Drain" or "Brain Leak"
- Lack of reliable power and water.
  - Bundled with poor public infrastructure (roads).

Misconceptions

- "Instruments must be simple"
  - The few users that are trained, are successfully trained.
  - Simple instrumentation is dependant on vendors and manufacturers.
- "Cost is always a main Barrier"
  - Resources can be pooled.
  - Equipment can be afforded but not maintained.

Possible Blueprints for Successful Design

- Duke University-Engineering World Health Competition for Underserved and Resource Poor Economies (CUREs)

  Business plan competition
  - Need finding through on-the-ground market research
  - Nonprofit business development
  - Prototype development

Possible Blueprints for Successful Design

- Program for Appropriate Technology in Health (PATH)

  Large-Scale Collaboration

  - Clearly defined need. Where public and private sectors can work in harmony.
  - Consensus among the public health community.
  - Public-Private collaboration to fund, design, field test and promote the product.

Questions

- If the projects that we are addressing are going to be based on cell phone technologies, how affected will they be to such external factors as the ones discussed?
- How about factors not discussed in this presentation? can you think of any?

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Technology, Social Context, and Milestone #2

9/29/2008

NextLab I, F'08, L5 (Luis Sarmenta) slide 1

Agenda

- Announcements
- Quick Overview of Mobile Technology
- More on Milestone #2
- Social and Cultural Issues

Announcements

NextLab Technical Sessions (with Luis Sarmenta)

- **Weekly on Tuesdays 3:30-5pm**
  - Open consultations, 3:30pm-5pm
    - Come to share your technical problems / progress
    - Get advice and feedback from Luis and other teams
  - Common time, 4pm-5pm
    - Time for "lectures" on common-interest topics
    - More open consultations
  - Location TBD (check your emails)
- **Software Dev Managers should go**
  - not absolutely required, but a good way to keep on track
- **But also open to everyone interested in more technical discussions**

Team Web Resources

- **Each Team should have these external resources:**
  - External blog (see under "Projects")
    - Includes Emerson videos, Milestone presentations, etc.
    - Public can view and comment
  - External Technical Documentation
    - Part of NextLab Wiki
    - documentation, notes, and "stable" versions meant for public use
- **We can also provide you these internal resources:**
  - SVN repository
  - internal forum
  - Internal wiki or Trac

Milestone #3: System Design (Oct. 20)

- **What are the components of the system?**
  - block diagram
- **How is it used?**
  - Use-cases
  - User interfaces
- **How does it work?**
  - What happens in different use cases
  - What data moves where?
  - What computation needs to happen?
- **Any potential difficulties?**
  - e.g., certain assumed functionality not being available
- **Initial implementation results**
  - Progress report
  - Crude quick demo, if possible

Quick Overview of Mobile Technologies

Mobile Phone Capabilities

- **Network Technologies**
  - GSM vs. CDMA
- **Voice**
  - Person-to-Person
  - IVR (interactive voice response)
- **Messaging**
  - Text Messaging (SMS)
  - Multimedia Messaging (MMS)
  - Email
  - IM
- **Internet / Web access**
  - 3G, GPRS, WiFi, WiMax
- **Phone-side Applications**
  - J2ME, Windows Mobile, Symbian, Python on Symbian, Android, iPhone, BREW, etc.
- **Phone-side Networking**
  - Bluetooth, IR, WiFi
- **Location**
  - GPS and AGPS
  - detecting cell towers from phone
  - operator-provided
- **Camera**
  - For photos and videos
- **TV Output**
  - e.g., Nokia N95 / N82
- **NFC**
  - as tag / card
  - as reader
- **Other sensors**
  - Accelerometer
  - Attaching other devices
  - using analog I/O
- **SIM card**
  - SIM toolkit text-based menus
- **Micropayments**
  - Bank-based
  - airtime credit-based

Milestone #2: Preliminary Needs and Context Assessment

Milestone #2 (Oct. 8)

- **Preliminary Needs and Context Assessment**
- **What does your partner think about your proposed solution?**
  - present your plan (e.g., Milestone #1 report and other materials) to your project partner (on Sept. 24, regardless of whether your are called)
  - Get their feedback
- **Does this affect your proposal?**
- **On-the-ground needs assessment**
  - What questions do you want to ask your target users?
  - (You don't need to have answers right now, but show your questions.)

Social Context

- **See Rachel Hall-Clifford's talk**
  - Contact her for feedback on needs assessments surveys
- **Who generated your idea and why?**
  - Technologically interesting? Perceived need?
- **Does your target population NEED your**
  - product or intervention? Who determines this?
- **Does your target population WANT your product?**
- **How open are you to changing your idea or product to correspond with local input?**

Technology

- **Cell-phone signal in your target locations?**
- **Do the target users have cellphones?**
  - How many have their own cellphones?
  - How many have access to one (e.g., village phone)?
  - Do people who have stores/shops/businesses, government offices, hospitals/medical facilities, schools, etc. have cellphones?
- **How about PCs?**
  - Do individuals have PCs? Laptops?
  - Internet? Dialup or High-Speed?
  - How about public offices (gov't, hospitals, etc.)?
  - How about internet cafes?

Economics of Technology

- **How much?**
  - Cheap phones (contract vs. no-contract)
  - Cheap cameraphones
  - SMS and MMS sending
  - voice
  - Internet / Web access (GPRS & 3G)
  - value-added services
  - **Do you pay to receive?**

- **What percentage of a family's income is spent on cellphone costs?**
  - What is the average income of a family?

User Behavior

- **How literate are your target users?**
- **How often do people use their cellphones and what for?**
  - (Text, chatting with relatives, conducting business, finding out if roads are blocked etc.)
- **What type of people are generally using cellphones?**
  - (Women, children, rich, middle-income, poor?)
- **What special/advanced uses people give their cellphones?**
  - paying for goods? Person-to-Person payments? Websurfing? Gaining local information?
  - Note: there's a difference between what services are available and what services people actually use!
- **Where do they go to top cellphones up?**
- **How often have people had cellphones stolen?**
  - Are people afraid of having their cellphones stolen?
- **Do people pay for goods and services with their phones?**
  - (If so, what? and where? Why do they not use real cash?)
- **Do people find them difficult/easy to use?**

More Questions

- **Think of the largest piece of information you might want to send (image, video, form).**
  - How long does it take to send it?
  - How much does it cost?
- **Details on other modes of use.**
  - What they do currently?
- **What social factors might prevent them from using the phone?**
- **In what situations is it rude to use a phone?**
- **How do people feel about you taking their picture with a cellphone?**
- **Does carrying a cellphone make you feel more successful?**
- **Do you share a phone or ever lend you phone to anyone - if so, for how long?**
  - (This is important if the phone is used as an identifier, or carries private info).

General Tips

- **"High-Tech" / not-so-cheap solutions may be OK if solution/application is such that such solutions only need to be used by a few, and not by the random public**
  - "Target users" are NOT always the same as "beneficiaries"
  - e.g., apps to be used by health workers for data collection / surveying, in a context where funding is available to provide workers with higher-end smartphones
- **If solution is meant to be used by end-users themselves, then need to support lowest common denominator**
- **More challenging, but also more potential for scalability and impact**

Again …

- **What is the problem we're trying to solve?**
- **How do we know that's a real problem?**
- **Does this problem really need a technological solution?**
- **Could this problem be solved <u>without</u> any digital technology?**

Don’t Forget

- Be aware of all these things and try to gather as much information as you can from the partner before and while you are designing your system

- You will almost certainly make mistakes

- The important thing is to be alert and be able to adapt and learn (“Fail early and Fail often”)

A Near Miss: The Importance of Context in a Public Health Informatics Project in a New Zealand Case Study

Stewart Wells and Chris Bullen

Journal of the American Medical Informatics Association
Volume 15 Number 5
September / October 2008

Health Informatics Project in New Zealand

- **Management of Hepatitis B**
- **Maori, Asian, and Pacific Islander populations have very high rates of HBV (5-13%) vs. European New Zealanders (0.4%)**
- **Health Informatics system**
  - Help with screening
  - Lab results
  - claims / payments
  - Keep track of immunization
  - Etc.

Problems

- **Premature implementation**
  - Start of project was delayed because of need to establish ethnically representative governance
  - Left insufficient time to develop software
- **Low Primary Care IT capacity**
  - Designers over-estimated user skill
    - interviewed experts
  - Limited availability of terminals, printers, phones
- **PCIS modification difficulties**
  - Software maintenance and compatibility issues
- **Identity Management**
  - Problems with Unique Patient Identifiers
  - Different ways to write name leads to different UPI → rejected claims → backlog
- **Poor Design**
  - batch rejection of claims if one claim fails
  - Limited user access to participant tracking system

Solutions

- Standardized naming conventions
- Individual claim rejection (not batch)
- Access enabled via website
- Barcode specimen identification
- Data matching requirements significantly relaxed
- Dedicated IT support staff from primary care nursing backgrounds recruited to liaise with software developers, and to provide on-site IT support

Context behind problems

- **Too much dependence on UPI**
  - Turned out not to be essential
  - Relaxed system still worked
- **Primary Care Environment**
  - Mostly private practices and morale was down
  - A lot of primary care providers did not invest in IT equipment
  - Also, not computer-saavy
  - Problem was designers interviewed computer-saavy "experts"
- **Political Context**
  - Delays due to political needs (e.g., ethnically representative governance)
  - Also … negative results (or fear of negative results) of solutions can shut down project due to political implications
- **Poor Testing of Software**
- **Conclusion … be aware of your context**

Stages of Design in Technology for Global Development

Jonathan Donner, Rikin Gandhi, Paul Javid, Indrani Medhi, Aishwarya Ratan, Kentaro Toyama, Rajesh Veeraraghavan

Computer, vol. 41, 2008, pp. 34-41.

Stages of Design in Technology for Global Development

- **Read this paper, and read Mike Gordon's slides**
- **Five Stages**
  - Wonder
  - Exuberance
  - Realization
  - Adaption
  - Identification
- **Several Examples**
- **Watch yourself go through these stages!**
- **"Fail early, fail often"**

Other Papers Today

- John C. Caldwell, “Cultural and Social Factors Influencing Mortality Levels in Developing Countries,” The ANNALS of the American Academy of Political and Social Science 510, no. 1 (July 1, 1990): 44-59.

- Robert A. Malkin, “Design of Health Care Technologies for the Developing World,” Annual Review of Biomedical Engineering 9 (July 25, 2007): 567-587.

MIT OpenCourseWare
http://ocw.mit.edu

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Fall 2008

eChoupals: A Study on the Financial Sustainability of Village Internet Centers in Rural Madhya Pradesh – Richa Kumar

Class Discussion - by anonymous MIT student

Sustainability

Sustainable Development - A form of progress that ensures human development and that "*meets the needs of the present without compromising the ability of future generations to meet their own needs*"[1]

Financial	Social/Cultural
Political/Institutional	Technological

[1]World Commission on Environment and Development

eChoupal Overview

- Commercial ICT project by ITC's International Business Division in 2000
- Enable Efficiencies in agricultural sector
  - Greater information exchange. Future's price Information
  - Create alternate market structures
  - Pooled Purchasing at Wholesale prices for Inputs
  - Weather Information

Business Model

- Network of eChoupals (Centers in villages with computer and Internet connection)
- Local Farmer acts as an Coordinator
  - Receives commission of 0.5% for every transaction
- ITC provides a collaborator for logistics
- Startup and training costs borne by ITC
- Operation cost – electricity, telephone borne by Coordinator
- Access to Price Information, email is Free

eChoupal Supply Chain[1]

Pricing (Sauda)

- ITC Price Quote
- Transaction slip given by Coordinator

Inbound Logistics

- Arrange transportation
- Transport Cost reimbursed
- Sometimes coordinators transport materials at own expenses

Lab Inspection

- Crop tested using electronic machine
- Farmers can contest test results
- Agree upon Price (for inferior products)

Weighing & Payment

- Weigh on large automated scale
- Immediate Payment

Hub Logistics

- Processing plants
- Warehouses

[1]Adapted from "What works Case Study:ITC's e-choupal and profitable rural transformation" By Kuttayan Annamalai and Sachin Rao, World Resources Institute.

Transaction Costs (Rs./MetricTon)

	Through the Mandi		Through the Choupal	
	Details of Cost	**Amount**	**Details of Cost**	**Amount**
Farmer Pays	Transport to mandi	100	Transport to Processing Plant[6]	0
	Bagging and Weighing Labor[2]	70	Bagging and Weighing Labor	0
	Labor Khadi Karai[2]	50	Labor Khadi Karai	0
	Handling Loss[2]	50	Handling Loss	0
	TOTAL	270	TOTAL	0
ITC-IBD Pays	Commission to CAG	100	Commission to Sanchalak[4]	50
	Cost of Gunny Bags[3]	75	Cost of Gunny Bags	0
	Labor for Stitching Loading[3]	35	Cash Distribution Cost[5]	50
	Labor for Unloading at Factory[3]	35	Labor for Unloading at Factory[5]	35
	Transport to Factory	250	Transport to Factory (Paid to Farmer)[6]	100
	Transit Losses	10	Transit Losses	0
	TOTAL	505	TOTAL	235

Savings per ton to ITC-IBD is Rs. 275.

Source: Kumar, Richa. "eChoupals: A Study on the Financial Sustainability of Village Internet Centers in Rural Madhya Pradesh." *Information Technologies and International Development* 2, no. 1 (2004): 45-74.

Courtesy of the USC Annenberg School for Communication.

Financial Analysis

- Only 16 months of data available. Analysis based on extrapolation of existing data
- Cost Recovery in 3.9 to 5.8 years
  - Opportunity cost of 10% to 20%
  - Probability of monsoon failure 20% to 50%
- Replacement cost of equipment may make project unsustainable.
- However calculation based only for Soybean procurement

Discussion

1. What can be some of the challenges in implementing the eChoupal model in other countries?
2. Can the model be evolved with the availability of low cost Mobile Technology?
3. Can the portal be used for other purposes – retail/information/farming best practices?

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Designing an Architecture for Delivering Mobile Information Services to the Rural Developing World

By Tapan S. Parikh & Edward D. Lazowska

Review and discussion slides by Oliver Wilder-Smith

Overview

- In this article Parikh and Lazowska present a new framework, CAM, for developing mobile applications targeted for users in the developing world based upon their experience with the limitations of current mobile platforms.

Why do we need a new framework?

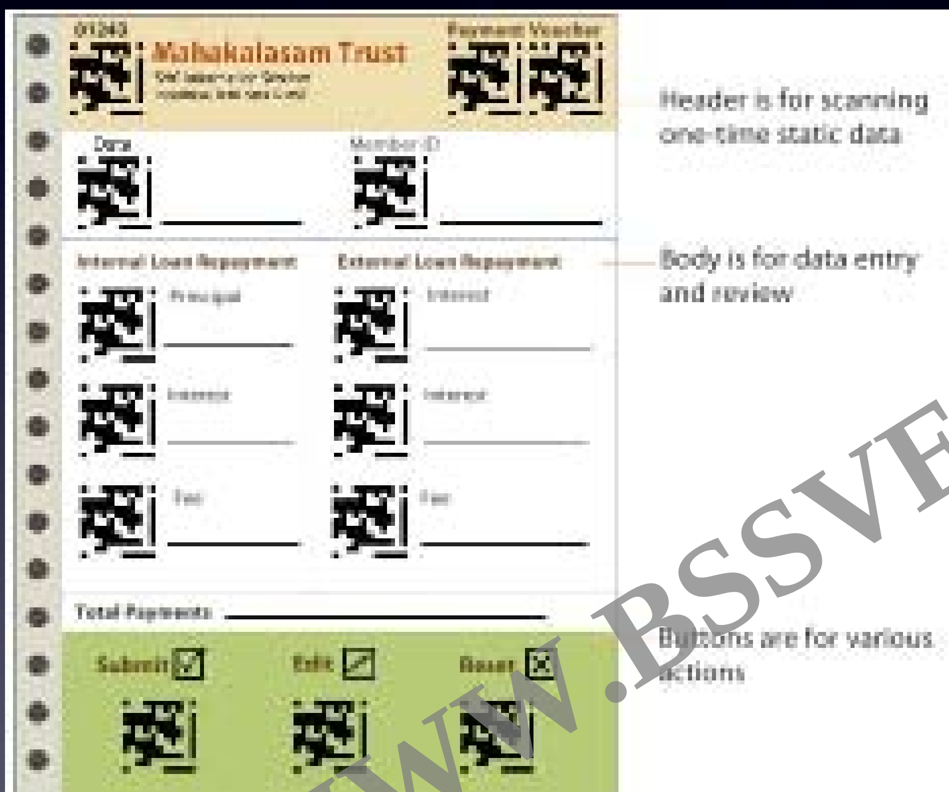
What limitations of previous systems does CAM address?

- Intermittent Connectivity - applications must seamlessly work in both online and offline modes.
- Text-Dependent UI - hardware and operating system constraints often prevent effective localization of text-centric UIs.
- Excessive Documentation - interface should be easy to use, and require minimal training to learn how to operate it.
- Assumptions about Usability Based on the Developed World
    - The concept of a private, personal mobile device.
    - The WIMP (Windows, Icons, Menus, Pointer) user-interface concept.

What did Parikh and Lazowska develop in response to these limitations?

- The CAM architecture makes use of camera phone technology to provide a flexible platform for efficient processing, navigation and transmission of paper-based information.

What does this look like, in practice?



Courtesy of Tapan S. Parikh. Used with permission.

Image source: Parikh, T. S. (2005) CAM: A Mobile Interaction Framework for Digitizing Paper Processes in the Developing World.

Copyright © 2006 IW3C2. Used with permission.

Image source: Parikh, Tapan S. and Edward D. Lazowska (2006). "Designing an architecture for delivering mobile information services to the rural developing world." In *Proceedings of the 15th International Conference on World Wide Web, 2006.*

Key Features of the CAM framework

- Automatic download of applications from scanning a bar code.
- Download and install done over MMS or WAP as needed.
- Applications and data are automatically cached on the phone for offline use.
- Seamless upload & download of data when the user returns to an area with network coverage.
- Leaves a paper record of transaction with the client.
- Use of audio prompts as well as image based text in the local dialect work to maximize comprehension on the part of both the client and the agent.

How might this be useful in our ongoing Nextlab Projects?

- One possible example from the *Nextmap Project*
  - CRS Disaster Management wants users to be able to enter answers to a survey on a mobile phone, for automatic transmission to the head office.
  - What would the advantages and disadvantages of a CAM style user interface be useful for such an application?
  - How does its usability compare to more traditional totally phone-based UIs?
  - Is this type of UI useful only for those unfamiliar with computer use, or does it have application with users who have experience with WIMP-based computer interfaces as well?

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Review: Design Studies for a FMS for Micro-credit Groups in Rural India

Anonymous MIT Student

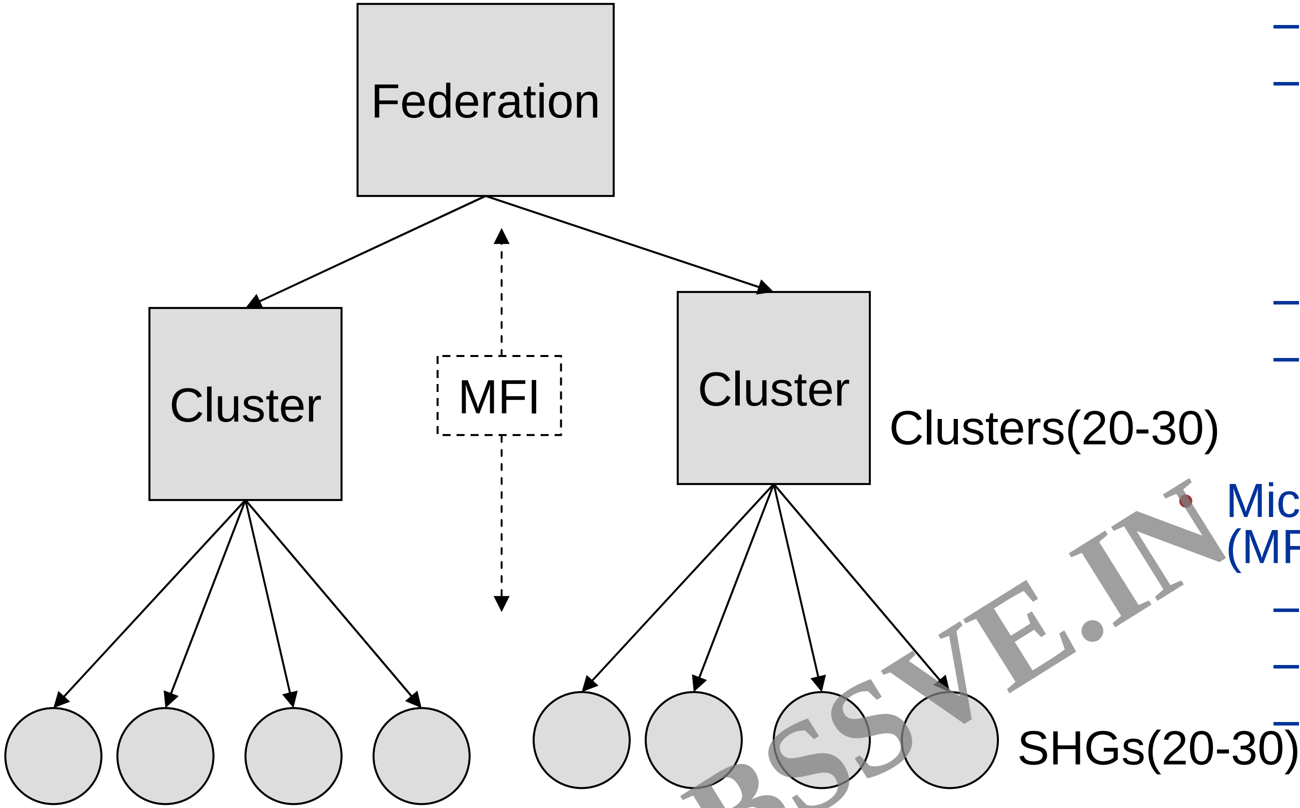
Massachusetts Institute of Technology

nextlab

General Overview

- Authors – Tapan Parikh(UW), Kaushik Ghosh(MIT), Apala Chavan(Humanfactors)
- Design a User Interface
  - Needs Analysis
  - Iterative Process
  - Prototyping
- Target – Community based micro-credit groups
- Focus – Rural India (Aurangabad, Madurai)

Micro-Finance in India



- Self help group (SHG)
  - 10-20 women
  - Basic transactions
    - Payments
    - Loans
    - Deposits
  - Monthly meetings
  - Community liability (high repayment rates)
- Micro-finance institution (MFI) are NGOs
  - Create,Support
  - Training
  - Linkages within & with banking sector

Micro-Finance Issues

- High Illiteracy (43% - 286 million Adults)
- Documentation at various levels
  - Tracking finances, credit
  - Better management of funds
  - Law requirements
  - High volume (small transactions)
- Remote Areas
- Technology limitations

Numeric Interfaces – Field Visit 1

- Genesis at Self-employed Women Association (SEWA) bank in Ahmedabad
  - "Oh, we can understand numbers fine, We can even do most simple calculations ourselves. It is only text and words we have a lot of difficulty with."
- Field Visit 1 : Aurangabad
  - Contextual Studies
    - Notebooks & Ledgers
    - Help for educated kids attending school
    - Sequential entries (tabular, ordered by name)
  - Paper prototypes

Field Visit 1

- Paper Prototype
  - Understood well
  - Good Feedback

Image removed due to copyright restrictions.

Figure 2 – "An early keypad-based paper prototype." In Parikh, Tapan, Kaushik Ghosh, and Apala Chavan. "Design studies for a financial management system for micro-credit groups in rural India," In *Proceedings of the 2003 Conference on Universal Usability*. Vancouver, British Columbia, Canada: ACM, 2003. doi:10.1145/957205.957209.

Field Visit 2 – Madurai, TamilNadu

- More Mature SHGs managed by CCD(Covenant Centre for development)
  - Started 150 SHGs, 4 Federations
- Context
  - Studied all levels, spending more time
  - Verification of learnings from Aurangabad
  - Relatively higher literacy
  - Schools kids and literate man involved
- Prototype
  - Interactive prototype (laptop) testing
  - People familiar with computers
  - Quick learners, ability to use touch device

Field Visit 2

- Prototype feedback
  - Does not match notebook format
  - More colors
  - Thrown off by Abrupt menus

Image removed due to copyright restrictions.

Figure 5 – "An interactive prototype..."
In Parikh, Tapan, Kaushik Ghosh, and Apala Chavan. "Design studies for a financial management system for micro-credit groups in rural India," In *Proceedings of the 2003 Conference on Universal Usability*. Vancouver, British Columbia, Canada: ACM, 2003. doi:10.1145/957205.957209.

Field Visit 3 - Madurai

- Extended 2 month study
  - Focused groups(32 women, A to D – order of literacy)
- Icons correlated to ideas are better!
  - Led to new interactive prototypes
  - Frequent sessions, rapid development
  - Direct feedback from users
- Final Design emerged
  - Well understood by 3 groups, D got quite familiar

Final Design

- Tabular Data Organization
- Numeric Data Formats
- Icons
- Iconic Legends (audio feedback)
- Discrete Task Spaces
- Color

Image removed due to copyright restrictions.

Figure 6 – "One of the final successful designs..." In Parikh, Tapan, Kaushik Ghosh, and Apala Chavan. "Design studies for a financial management system for micro-credit groups in rural India," In *Proceedings of the 2003 Conference on Universal Usability*. Vancouver, British Columbia, Canada: ACM, 2003. doi:10.1145/957205.957209.

Conclusions

- Context is very important!
- Numeric to Iconic Correlation
- Importance of physical models and tangible artifacts (touch & feel)
- Learnt the entire system – MIS being developed
- Hybrid technologies (paper using RFID etc)

Questions

- Why not just Ahmedabad (first study)?
- Quest for focused lead Users?
- Does this help? – Study was not for mobile phones
- Experiences with UI design so far?

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What does this signify to you?

What would the thumbs up mean to this guy?

Another example: which one would be better for Bangalore, India?

Image source: Medhi, I., A. Sagar, and K. Toyama. "Text-Free User Interfaces for Illiterate and Semiliterate Users." *Information Technologies and International Development* 4, no. 1 (2007): 37-50. Courtesy of USC Annenberg School for Communication.

Lesson #1: Pay attention to religious & cultural nuances in designing GUIs

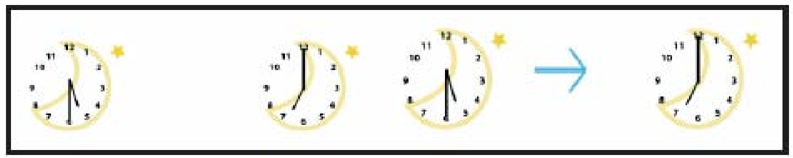

Figure 4. Ambiguity in iconic representation due to cultural biases: Our initial design indicating start and end times for a job places the start time at left (left). This is misinterpreted in Muslim culture. Adding an arrow avoids this problem (right).

Figure 5. Designs for the "residence" icon. Our initial design (left) was perceived as a hut; the final design (right) is more in line with what our subjects interpreted as an urban residence.

next billion network

Image source: Medhi, I., A. Sagar, and K. Toyama. "Text-Free User Interfaces for Illiterate and Semiliterate Users." *Information Technologies and International Development* 4, no. 1 (2007): 37-50. Courtesy of USC Annenberg School for Communication.

Text-Free User Interfaces for Illiterate and Semiliterate Users

Indrani Medhi, Aman Sagar and Kentaro Toyama

Literacy Rates in Africa 2005

Overall: Less than 60%

Burkina Faso	28.5%
Chad	53.6%
Gambia	42.4%
Guinea	41.1%
Niger	18.7%

Rates are even lower in women: 14% in Somalia.

Source: Encarta

Basics for Semi-literate/illiterate audiences

- Use voice feedback if possible
- Minimal use of text (but numbers are ok!)
- Active visual response on mouse-over
- Landmarks for geographic navigation
- Make help readily available

Let’s get into more insightful analysis.

Lesson #2: Semi-abstracted or photo realistic graphics are more effective than iconic

Collection of Web-style icons removed due to copyright restrictions.

Collection of photos of common technology objects removed due to copyright restrictions.

Lesson #2: Simple for you may not be simple enough

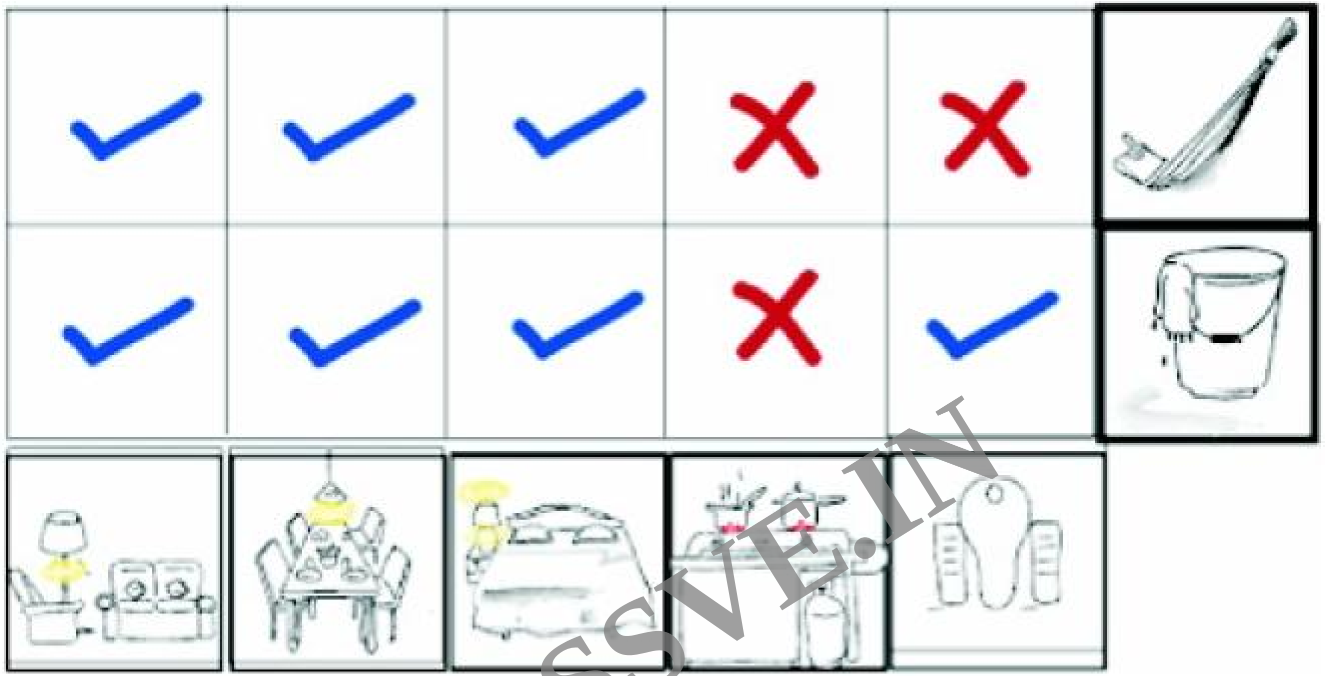

Image source: Medhi, I., A. Sagar, and K. Toyama. "Text-Free User Interfaces for Illiterate and Semiliterate Users." *Information Technologies and International Development* 4, no. 1 (2007): 37-50. Courtesy of USC Annenberg School for Communication.

This graphic was more easily understood

Image source: Medhi, I., A. Sagar, and K. Toyama. "Text-Free User Interfaces for Illiterate and Semiliterate Users." *Information Technologies and International Development* 4, no. 1 (2007): 37-50. Courtesy of USC Annenberg School for Communication.

Lesson #3: GUIs are a superior option if possible

Authors tested theories in Bangalore experiments

Job Search Task

- Tested text interface and text-free graphical interface with help – the winner: text free graphical with help

Finding Location on a map task

- Text-free versus text-based - text-free was far more successful.

Lesson #4: Test interfaces with your end user and listen to your customers

Photo of five people of different races removed due to copyright restrictions.

That's it, thanks!

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An Introduction to the GSMA's Mobile Innovation Market and Development Fund

For

Massachusetts
Institute of
Technology

Next Billion Network Initiative

GSMA Membership Types & Stats

- **Full Membership**
  - Full Membership is open to:
    - Licensed 2nd & 3rd GSM mobile network operators (GSM, GPRS, EDGE, 3GSM, HSPA)
    - Government administrations
- **Full Membership Statistics**
    - Total number of Full members: 754
    - Total number of Associate members: 211
    - Representing All countries

The GSM Association Board

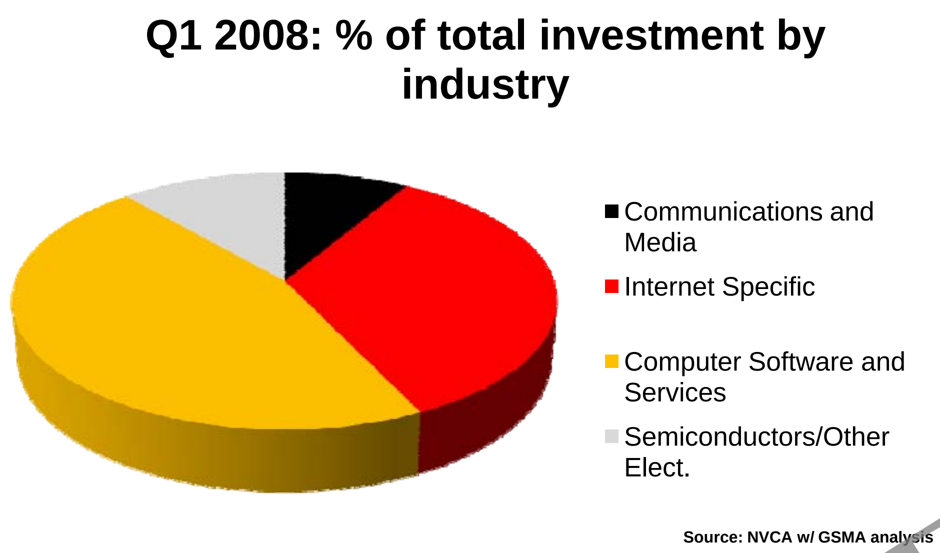
Hutchison Mobile: Craig Ehrlich (Chairman)
GSMA: Rob Conway (CEO)
AT&T: Bill Hague EVP
Bharti: Manoj Kohli, President & CEO
China Mobile: Lu Xiangdong, EVP
China Unicom: Zhang Fan, CTO
KTF: Dr Young-Chu Cho, CEO
mobilkom austria: Boris Nemsic, CEO
MTN: Phuthuma Nhleko, CEO
MTS: Leonid Melamed, CEO
NTT DoCoMo: Takanori Utano, EVP/CTO
Orange SA: Brigitte Bourgoin, EVP
Orascom: Naguib Sawiris, CEO
SK Telecom: Shin-Bae Kim, CEO
Singapore Telecom Mobile: Ng Noke Weng, CTO
Smart Communications: Napoleon Nazareno, CEO
Softbank: Tetsuzo Matsumoto, CSO
T-Mobile: Joachim Horn, CTO
Telefonica Moviles/02: Vivek Dev, COO
Telenor Mobile: Arve Johansen, Deputy CEO
Telstra: Sol Trujillo, CEO
TIM: Franco Bernabe, CEO
Turkcell: TBC
Vimpelcom: Alexander Izosimov, CEO
Vodafone: Terry Kramer, Chief of Staff
Zain Group: Dr Saad Al-Barrak, CEO
EMC Chair: Stein Hansen

Mobile Innovation Market - Summary

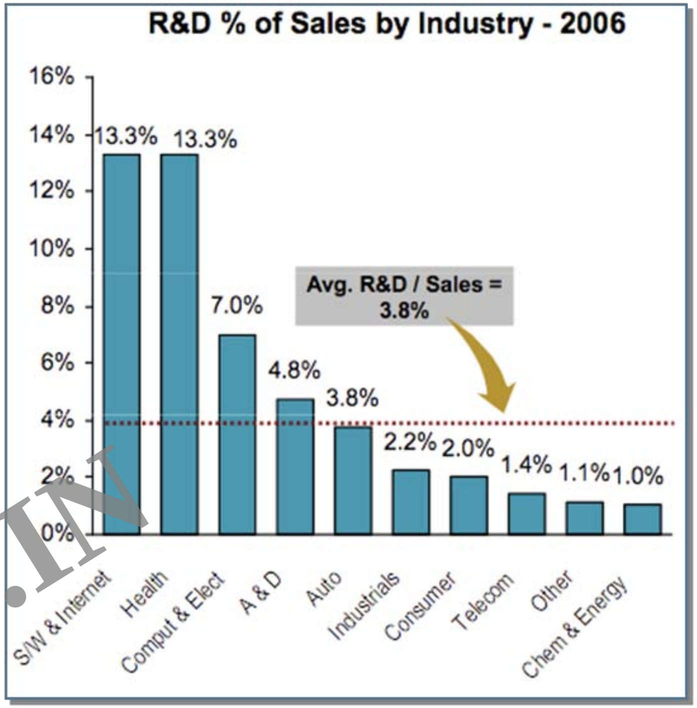
- **Purpose is to develop an ecosystem that brings together Operators, Investors, Innovators and Corporate Partners to drive mobile innovation**
  - Ensure mobile innovation aligns with Operator business strategies
  - Accelerate time to innovation and time to market by "vetting" and promoting top innovators

Program Addresses Growing Market Need

Flat to declining investment



R&D under-indexes other industries



Source – Booze Allen Hamilton

Potential of mobile is exciting , but investor excitement is tempered by:

- Role of incumbents in the eco-system
- Limited number of home run exits
- Fragmentation of underlying mobile platforms

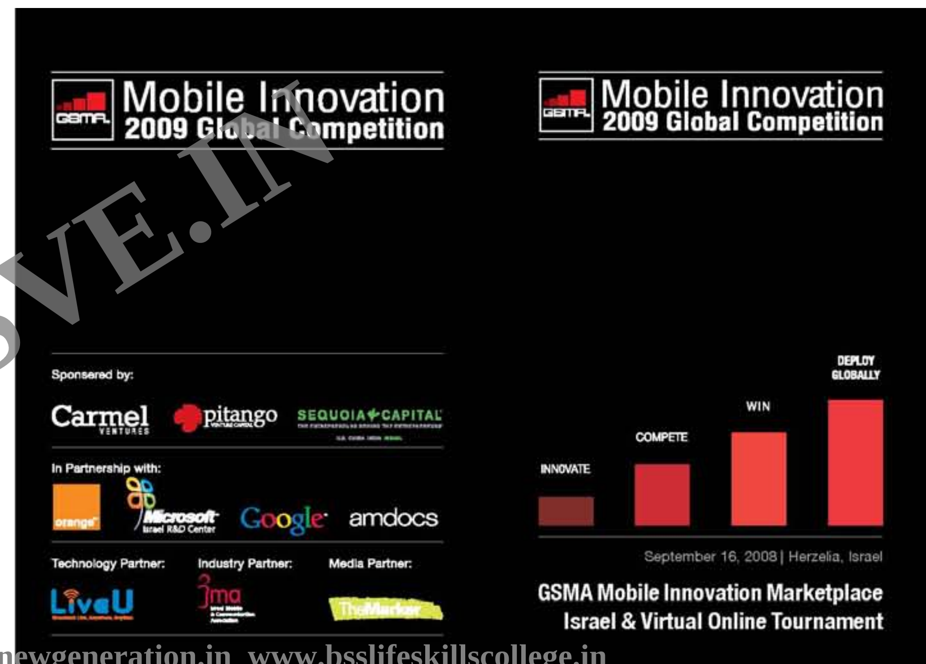
Cultivating a Following

Mobile Innovation Market Events
Barcelona, Atlanta, Tel Aviv, and Macau
Thought leadership sessions with mobile innovation ecosystem influencers
Mobile Innovation Awards Regional Tournaments and Finals
Speed dating and networking sessions

Agenda

The New Mobile Model – cooperation, coopetition, collaboration, etc

14:30–15:00	Registration and Networking
15:00–15:15	Opening keynote address: **Bill Gajda** - Chief Commercial Officer, GSMA
15:15–15:30	Keynote presentation: **Dr. Mike Short** - Vice President, R&D, Telefonica O2 Group & Past Chairman GSMA
15:30–16:20	Virtual Top 9 Innovator Pitch Presentations: Part I *Top Innovator companies will deliver concise and compelling pitch presentations, and then face probing Q&A from a distinguished panel of judges.*
16:20–16:30	Coffee Break
16:35–17:25	Virtual Top 9 Innovator Pitch Presentations: Part II *Top Innovator companies will deliver concise and compelling pitch presentations, and then face probing Q&A from a distinguished panel of judges.*
17:25–17:35	Coffee break
17:35–18:15	Panel Discussion: *The New Mobile Model – cooperation, coopetition, collaboration, etc* Moderator: **Bill Gajda** - Chief Commercial Officer, GSMA Speakers: **Hugo Barra** – Group Product Manager and Global Product Lead for Mobile, Google; **Avner Mor** - General Manager of the Telecom Products Group, Microsoft Israel R&D Center; **Dana Porter** – Vice President of Marketing, Amdocs; **Erez Paz** - Vice President, Marketing and Content, Partner Communications
18:15–18:25	GSMA Mobile Innovation Global Competition– Virtual Tournament Awards Presentation *Global Semi-Finalists & Global Finalist Award Announcement*
18:25–19:30	Evening Networking Cocktail Event



Discovering Top Innovation

5 Awards Categories
Most Innovative True Mobile Start-up
Most Innovative Consumer Application
Most Innovative Application in a Vertical Market
Most Innovative Carrier Infrastructure or Platform
Most Innovative Wireless Device-centric Technology

If You Build It, They Will Come

Innovators

- Forum for controlled global exposure to target audiences (investors, customers, OEMs, partners, et c)
- Act as a “solver” & respond to posted requirements
- Tools to initiate dialogue with prospective customers and partners
- Tailored marketing for different target stakeholders

MNOs

- Understand investment landscape
- Identify and assess opportunities and threats
- Act as a “seeker” & post requirements
- Expose APIs to 3rd parties
- Propose trials and commercial relationships with entrepreneurs
- Develop trusted relationship with VCs and entrepreneurs
- Coordinate resources for analysis

www. Mobileinnovation .org

Investors/VCs

- One stop search for mobile investment opportunities
- Due diligence tool to understand market sectors and competing players
- Track the progress of companies interested in following
- Find great companies before other investors
- Interact with “demand side” of the equation

Suppliers / OEMs

- Improve technology scanning
- Enhance innovation management
- Establish trials and commercial partnerships one stop search for opportunities to invest in or acquire technology companies
- Facilitate collaborations across different sectors and disciplines

Development Fund - Who We Are

- Work with mobile operators to accelerate mobile solutions for people living under $2 per day
- Launched in 2006 to catalyse the uptake of GSM technology for social and economic development
- Core part of the GSMA, the operator-led trade association representing the mobile industry

Development Fund

Our Beliefs

- Doing good is good business
- The mobile industry is uniquely positioned to deliver economic & social value
- With more than 3 billion users, base of pyramid markets are the future for mobile growth and innovation
- By working closely with mobile operators we can accelerate the benefits of mobile for all

Our Objectives

- Increase the number of effective, scalable and replicable development initiatives using mobile technology in emerging markets
- Implement these initiatives in a scalable and sustainable fashion, bringing socio-economic benefits to individuals and communities
- Increase awareness among governments and the development community of how GSM acts as an agent of development and can be used to bridge the digital divide

What We Do

- Catalyse Innovation
- Drive Market Scaling
- Increase Knowledge Networking

GSMA Development Fund

Our Focus Areas

Connectivity

Energy

mServices

GSMA Development Fund

Highlights To Date

- 25 projects in 13 countries with 20 operators
- Over 150,000 persons directly impacted and 1 million indirectly
- 35,000 Community Phone entrepreneurs
- 600 GSM Internet cafes in 5 countries
- 4 HSPA connected Internet cafes in Africa with 2 operators
- GSM voice and data services rolled out to 25,000 refugees in Uganda
- GSM voice and Internet services to UN Millennium Village in Rwanda
- Biodiesel powering 350 BTS in India
- Green Power for Mobile programme launched

GSMA Development Fund

Mobile Innovation Market

Thank you!

Andy McGuire
VP – Mobile Innovation Market
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www.mobileinnovation.org

MAS.965 / 6.976 / SP.716 NextLab I: Designing Mobile Technologies for the Next Billion Users
Fall 2008

Medical Information System in Developing Countries

Reviewed by anonymous student

MIT Sloan, Class of 2009

Background

- Low healthcare spending per capita in developing countries
  - $32 per capita in developing countries (WHO standard is $60). $3724 per capita in high income countries
  - Tertiary hospitals in developing countries consumed a huge portion and less than a quarter goes to public health measures and clinical cares

How information technology can be employed to improve the quality of healthcare?

EMRs Improve Efficiency

- 2 years after Electronic Medical Records (EMR) was implemented in Colorado and N.W. Kaiser Permanente
  - 9% decrease in office visits
  - 11% decrease in primary care visits
  - 5-6% decrease in specialty care visits
- Long term study of US Veterans Health Admin has shown a 6% improved efficiency per year
- Developing countries still use labor-intensive collection techniques
  - Insufficiently comprehensive, inaccurate and often out of dated

Global Health Resource Tracking System

- It contains valid, detailed data (who, what, where, how much)
  - Impose on any public or private entity no more than a minimal burden in terms of its provision of the information needed to populate the system.
  - Readily harmonize with and connect to the existing data systems of receiving countries and all donor entities.
  - Be easily accessible via the Web and flexibly searchable by every data element in a variety of languages.
  - Enjoy broad ownership, official buy-in, and use, with long-term support from a diversified funding base.

Require that practical data systems exist!

System Designs

- Schema design can be either top-down or bottom up approach (trade-off between efficiency and standardization)
- EMR should be built with open-source software
- EMR should include standardized medical languages (UMLS) which have multi-lingual versions for records
  - Errors due to regional differences in names, medical terms can lead to serious medical errors

Multi-factorial Approach

- There are other factors beyond technology: corruption, inequalities, imposition of sub-optimal policies/technologies, lack of or incorrect information
- The disparities of access and quality of care within the current health system may be further exacerbated by the planned improvements
- Poor infrastructure, but reliable wireless system, over 80%population live in range of cell towers

PIH-EMR in Peru

- A community-based treatment program for drug-resistant tuberculosis in slums of Lima, started in 1996, by Partners In Health (PIH), Socios En Salud (SES), and Peruvian Ministry of Health. It provide high-quality care, lower costs, reduce the risk of spread of MDR-TB.
- Health Electronic Medical Record (PIH-EMR) was implemented in 2001.
  - Web-based EMR based on open-source tech and backed by Oracle database in English and Spanish
  - 29000 patients, 7600 of which have received treatment
  - Include initial history, physical exam, lab results and medications
- Significant fewer errors than paper/spreadsheet; match the usage data in the pharmacy to within 3% and use for ordering medine. TB-Lab module reduce processing delays from 30 to 8 days, reduce errors by 60%
- PIH-EMR has recently been adopted by the Peruvian National Tuberculosis Program - these types of systems are feasible to implement in resource-poor settings.

HIV-EMR in Haiti

- Implemented in 1999 by PIH and Zanmi Lasante, covered 9 clinics in an area with no roads.
- 'Directly Observed Therapy with Highly Active Antiretroviral Therapy' (DOT-HAART) for HIV is modeled on successful tuberculosis control efforts like the PIH-EMR.
  - an open source web-based system based on the PIH-EMR. Satellite-based internet access at each site. Offline client for data entry and review to solve the problem of inconsistent power and internet
  - Over 12,000 patients; 3,051 of which are receiving ART.
  - The system records clinical data including history, physical examination, social circumstances and treatment.
  - Decision support tools provide allergy and drug interaction warnings and generate warning emails about low CD4 counts.
  - Check lab result, reporting tools, drug regimen analysis,
  - drug stockouts have fallen from 2.6% to 1.1% and 97% of stock requests delivered were shipped within 1 day. reduce costs in having stockouts

Key Takeaway

- The most significant barriers is the detailed information concerning disease incidence, health practices and available resources
- Implementing healthcare technologies within larger collaborations that improve the overall public health infrastructure. Open standards and open source development in a collaborative environment.
- The need for community data collection, and feasibility of using ICT to enable data collection, and improve information flow in developing countries.
- EMRs is a foundational technology. The projects illustrate that the creation of long-term relationships to build infrastructure and solving systemic problems to provide health care can be beneficial to both the patients and the projects involved.

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Research Summary

"An information system and medical record to support HIV treatment in rural Haiti"

Fraser HS et al, BMJ 13 November 2004

Photo removed due to copyright restrictions.
Clinical staff working with a web based medical record system.
Fig. 1 in Fraser HS et al, *BMJ* 13 November 2004.

Presentation: Clark Freifeld

System Configuration

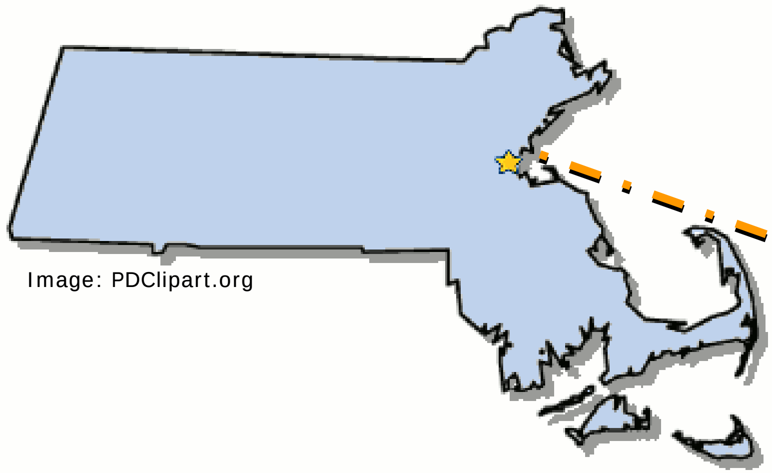

Image: PDClipart.org

Image: NASA

Image: CIA World Factbook

Advantages

- Easier to track patients
- Secure
- Clinical tracking:
  - Drug supply
  - CD4 counts
- Automated alerts
  - Drug interaction
  - Regimen vs. CD4 check

Challenges

- Limited connectivity
- Unreliable power
- Limited IT expertise
- Dust, humidity, security

Solutions

- Hosted in Boston
- Offline client store-and-forward
- Satellite Internet
  - $6000 + $260/mo
  - 30 – 256 kbps upload
  - 256 - 400 kbps download
  - Physical equipment must be deployed, maintained, protected
- SSL

Results

- Nine months usage
- 2500 patients,
  - 1300 fully registered
  - 800 full ARV regimens recorded
- 150 new each month
- To be expanded to other disease categories, patients

Limitations

- At that time, custom software rather than OpenMRS
- Data not always up to date
- No data on change in drug supply chain efficiency
- No specific data on training time and cost
  - Software forms based on paper forms

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Handheld computers for rural healthcare:

Experiences from research concept to global operations

Decision Systems Group, Brigham & Women's
Harvard Medical School
MIT-Media Lab Asia
Dimagi, Inc
Concept Labs

overview

design + implementation

- project objective
- hardware design
- user interface
- implementation

developmental entrepreneurship

- results
- transition to entrepreneurship

project ca:sh -- objective

Develop a handheld electronic medical record (EMS) system for health workers in remote areas, to enable

- quick access to medical records
- a collection of data for analysis of trends + records

Addresses two important problems:

- Prenatal Care
- Child health

objective

Image removed due to copyright restrictions.

Source: Anantraman, V. et al., "Handheld computers for rural healthcare: Experiences from research concept to global operations." *Proceedings of Development by Design*, 1-10.

overview

design + implementation

- project objective
- system design
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developmental entrepreneurship

- results
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system design

- **Compaq iPAQ** 3765
- device is **self-contained**; runs both server and client
- open source **linux** for easy migration
- data stored on **compact flash** cards

Image removed due to copyright restrictions.

Photo: Anantraman, V. et al., “Handheld computers for rural healthcare: Experiences from research concept to global operations.” *Proceedings of Development by Design*, 1-10.

user interface

- designed in 2 weeks with active participation of target users
- minimize free text entry

Images removed due to copyright restrictions.

- divided into 5 modules

Images: Anantraman, V. et al., "Handheld computers for rural healthcare: Experiences from research concept to global operations." *Proceedings of Development by Design*, 1-10.

overview

design + implementation

- project objective
- system design
- user interface
- implementation

developmental entrepreneurship

- results
- transition to entrepreneurship

implementation

- deployed in 4 ballabhgarh subcenters over 5 months.
  subcenters included early and late adopters of technology

- **phase 1 training:** use hardware

- **phase 2 training**: use software

overview

design + implementation

- project objective
- system design
- user interface
- implementation

developmental entrepreneurship

- results
- transition to entrepreneurship

MITSloan

results

- expansion to 10 clinics
- complete replacement of paper records
- high acceptance of technology
- **Dimagi** was created in 2002 to help the technology scale up

Image removed due to copyright restrictions.

Photo: Anantraman, V. et al., "Handheld computers for rural healthcare: Experiences from research concept to global operations." *Proceedings of Development by Design*, 1-10.

transition: research to entrepreneurship

- **redesign to ensure wide applications**: cheaper handhelds; software generalized to include potential integration of GPS, wireless modules, cameras, etc.
- **funding:** difficult to obtain venture capital, targeted social venture, angel investors, grants, government funds
- **market focus:** develop robust business model; allow technology to be used in non-developing countries
- **partnerships:** for advice, focus, + customer base

discussion

can you think of other projects that have made a successful or unsuccessful transition to entrepreneurship?

does your nextlab project have the potential for expansion? what has your group discussed? what are the strengths and challenges

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6.976 / MAS.965 / SP.716 - Nextlab I

The Emerging Role of Cellphones;
Resource-friendly healthcare

Gari Clifford, PhD
Principal Research Scientist, HST

Harvard–MIT
Health Sciences & Technology

Existing Technology & Infrastructure

- Old legacy hardware & instruments
- Generally paper notes, static information
- Poor communication channels
- Poor drug storage and supply
- Poor waste disposal
- Poor transport
- Intermittent electricity
- Information shortage
- Skills shortages

What is changing?

- **Over 80% of humans live within range of a cellphone tower**
- **Over 2 billion cellphone subscriptions worldwide**
- **Cellphone usage increasing up to 30% annually***
- **Cost per *flop* dropping analogous to Moore's law**
- **Integrated peripherals increasing every year (Camera, Video, Accelerometer, GPS, larger screens)**
- **Battery storage technology improving every year**
- **Cost per kilobyte dropping every year**
- **Cost of hardware dropping every year**

Map removed due to copyright restrictions.
Tigo's GSM coverage in Guatemala.
http://www.tigo.com.gt/seccion/mapa-de-cobertura-gsm-y-35g

*** (India, 2007)**

Why particularly cellphones?

- Don't think of it as a phone – it's a mobile hand-held computer with integrated communication and sensors.
- What's unique about this hardware for medical care?
  - **Multi-functional and self-contained**: but parts are no use for other devices; user will not strip it for battery or other uses.
  - **Easy to charge** even when no grid electricity available (can even use wind-up generators),
  - **Easy to hide**, disguise and keep safe (in pocket),
  - **Interchangeable & standardized**,
  - **Easy to replace** – plenty of supply,
  - **No proprietary cabling** to replace (wireless communication)
  - **Significant computational power** in one device! – **A.I.?**
  - **Humans want (*need*) to communicate** – they will ensure that the device is always working and are highly motivated to have it repaired quickly if it is their primary method of communication!

An example: Cervical cancer screening

Issues:

- Skills to read images of cancer are limited (e.g. menopause is difficult to differentiate from cancer)
- 2nd opinion requires a multi-step process to send image & receive feedback
- Patient may have left clinic (and never return) by time diagnosis arrives
- Images can be out of focus over/under-exposed or contain lighting artifacts

Image removed due to copyright restrictions.
Three stages in development of cervical cancer, from http://www.preventcervicalcancer.ie/what_causes_it.asp.

Peri-urban and rural health care

- ~5 minutes per patient!
- Rapid & accurate evaluation and information retrieval needed

What can cellphones do to help?

- Replace existing cameras for taking and storing images
- Provide instant transmission of images for remote diagnosis
- Archive data for follow-up and quality audits
- Provide training for automated classifiers:
  - ***Artificial Intelligence*** (AI) can be thought of as the mimicry of complex human task, such as medical diagnosis, by a computer.
  - AI can be achieved through computer algorithms that have been trained on data labeled by humans
  - AI algorithms that have been trained on data labeled by human experts can often be taught to classify similar data as well as the human experts themselves (in less time, and more consistently)

[Balas 2001, Phinjaroenphan *et al* 2004, Tulpule *et al* 2005, Zimmerman *et al* 2006, Luck *et al* 2006, Gordon *et al* 2007]

Usage Scenario

- Standard Smartphone with built-in 5MP+ camera and flash.
- Transmit data to remote website/database
- Multiple experts label images (and parts of images)
- Consensus of experts decides on real classification
- SMS diagnosis and treatment back to doctor
- Patient treated immediately – not lost!

Future directions: Decision support

- After data is labeled, **software is trained** and downloaded to phone

- On-board software will:
  - present image to on-board classification software
  - upload image to remote server with meta-data
  - provide feedback *to* user

- **Feedback** *from* user to improve data set after expert consultation

- Automated back-up of data, **classification accuracy** assessment and **treatment efficacy** tracking

- Users can be encouraged to **improve data collection at the source**; if the algorithm isn't sure, or thinks the image is out of focus or at strange angle, it can ask user to take another picture

Modality of use

- AI can provide instant classification in most cases
- In dubious cases, images can be retaken with software guiding user; in this way, user is trained to take better photos.
- If still unclear, image is referred to multiple experts.
- Expert classifications are folded back into training set and phone software is updated automatically.
- Database can cross-validate in background and detect if changes are occurring in population – Is the disease manifesting in a previously unknown manner? Software can adapt to changes in population over time.
- Software can show user where it suspects the cancerous region may be and provide an explanation of why it is cancerous (“large dark mass”) or not (“patient is post-menopausal”)

Conclusions

- Potential of ***mobile computing*** is enormous
- Can provide expert diagnosis in an instant
- Will provide a large database of cases to continue improvements of diagnosis, and of allow doctors to track patient's recovery over time
- Low cost and easily maintained technology.
- Very few points of failure (no cables, local hard disks or electricity supply problems)
- System can train local talent and improve local expertise
- Secure Integrated Electronic Medical Record will allow users to keep control of their medical data without worrying about it being lost when they transfer between clinics, see new doctors, or go on holiday.
- **Software-intensive, extensible, resource-light solution!**

Summary – why can this work where before it was difficult?

1. **Driven from within** - cellphones are not being imposed on developing countries - they are self-identified wants/needs.
2. **Users are incentivized to maintain them** (electricity and functionality) as they are their primary communication facilitator after the voice.
3. **Ubiquitous** - it's easy to get a replacement part/phone.
4. **Easy to carry & conceal** and harder to steal than usual
5. **No peripherals or cables required** so there are few points of failure
6. **Backing-up is automatic**, it doesn't require the user to remember or bother.
7. **The platform is intelligent** - it can be programmed in a similar manner to a computer and can assist in diagnosis and training. ***It can teach AND learn***.
8. **Flexible** - can provide a general platform for data gathering and diagnosis/treatment
9. **Extensible to other fields** (e.g. tracking agricultural crop growth/diseases)

Reading List

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Fall 2008

A web-based laboratory infromation system to imporve quality of care of tuberculosis patients in Peru

Joaquin A Blaya, Sonya S Shin, Martin JA Yagui, Gloria Yale, Carmen Z Suarez, Luis L Asencios, J Peter Cegielski, Hamish SF Fraser

Presentation by anonymous MIT student

Vision

Decrease turn-around-time and error of TB testing using an electronic labratory system

TB Workflow

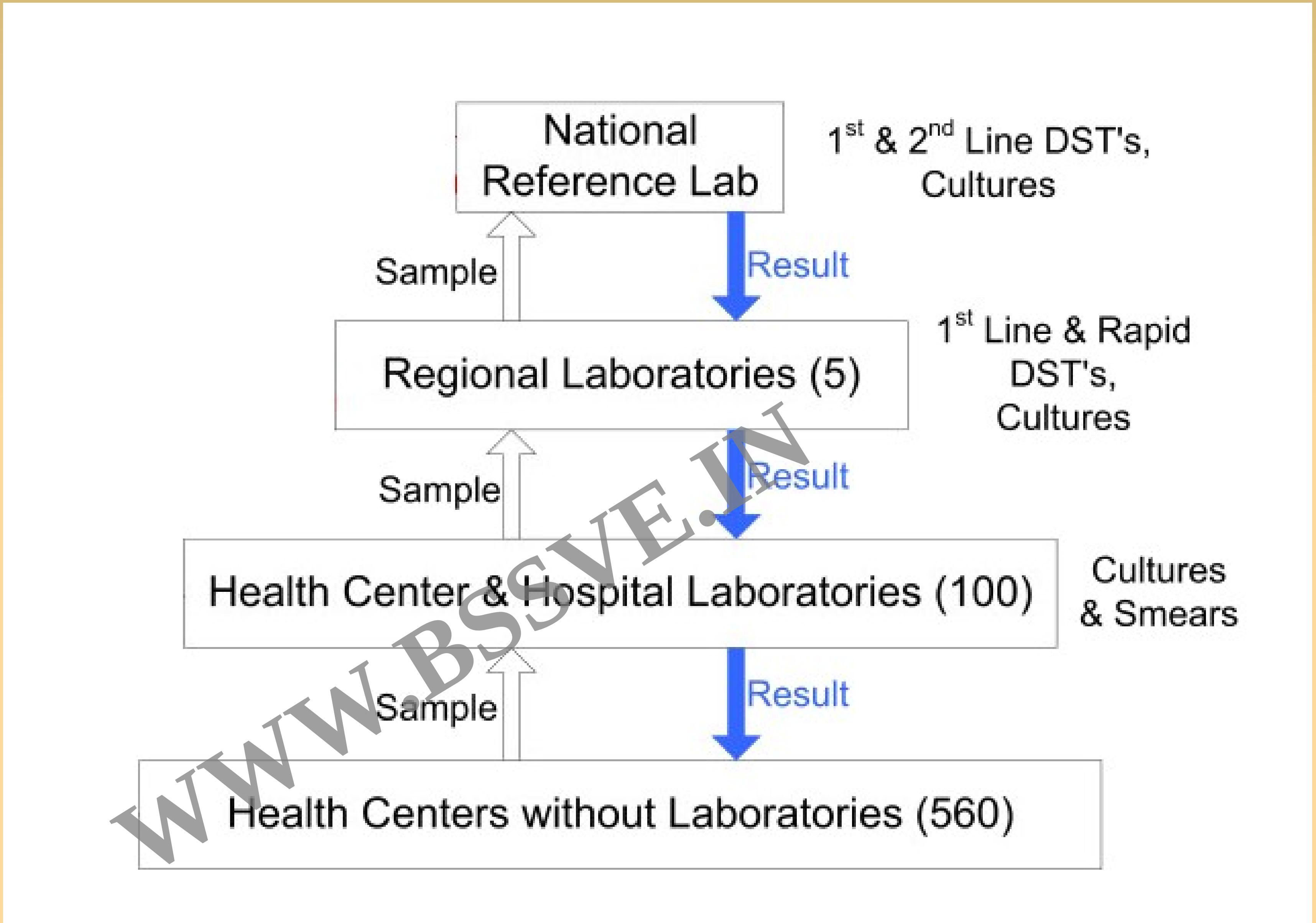

Image: Blaya, J. A., et al. "A web-based laboratory information system to improve quality of care of tuberculosis patients in Peru: functional requirements, implementation and usage statistics." BMC Medical Informatics and Decision Making 7, no. 33 (2007). doi:10.1186/1472-6947-7-33. Courtesy of J. A. Blaya et al.

Steps

- Ran needs assessment
  - What information was needed
  - How to fit it into current workflow
- Created system with stakeholders
- "e-Chasqui"
- Trained workers

Image: Wikipedia
(public domain)

News

- Fully implemented March 2006
- 99% of results viewed online
- Increased usage:
  - 2006 - 1865 views per day
  - 2007 - 4501 views per day
- $0.53 per sample

Contributions

- Cut down turn-around-time to 8 days
- Help quality control
  - Double entry of patients
  - Reminders

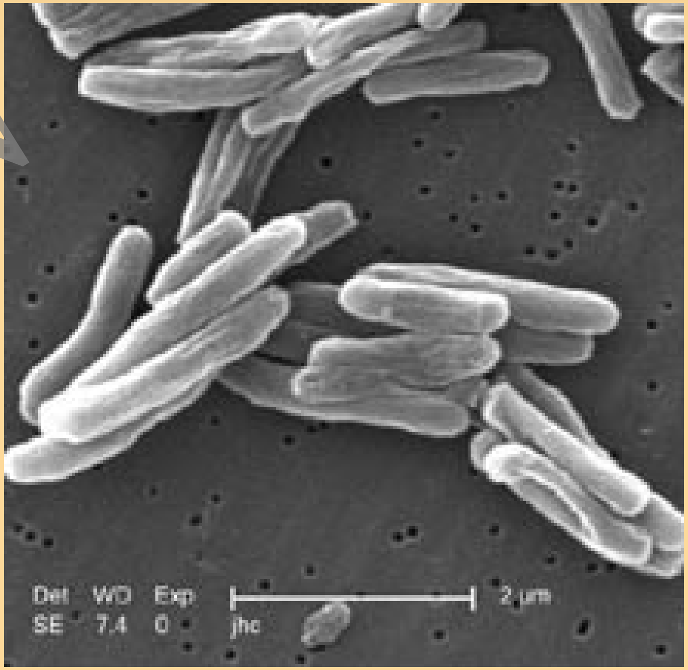

Image: US CDC

Questions

How will your system will fit into current workflows?

Questions

Are you in contact with your stakeholders at all stages?

Questions

Have you thought about training?

Questions

What will make your users ”buy in” to your system?

Questions

Is your system a part of a larger structural improvement?

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Fall 2008

HealthLine: Speech-based Access to Health Information by Low-literate Users

J. Sherwani, N. Ali, S. Mirza, A. Fatma, Y. Memon, M. Karim, R. Tongia, R. Rosenfeld

Anonymous MIT student

10/27/08

Introduction

- Health care shortage in developing countries
- Community health workers receive basic training
- "Providing access to reliable health information for health workers in developing countries is potentially the single most cost effective and achievable strategy for sustainable improvement in health care"

Related Work

System	Health	Speech interface	Data access	Designed for low literate users
Carnegie Mellon University's Communicator travel information system		X	X	
MIT's Jupiter weather information system		X	X	
Amtrak's "Julie" system		X	X	
Berkeley's TIER group's Tamil Market project		X	X	X
Designing a Graphical User Interface for Healthcare Workers in Rural India, ACM CHI 1997	X			X
Handheld computers for rural healthcare, experiences in a large scale implementation. In Proceedings of Development By Design, 2002	X		X	X
Design studies for a financial management system for micro-credit groups in rural India. Proc. of the ACM Conference on Universal Usability, ACM Press (2003)				X
VoicePedia		X	X	

Community Health in Pakistan

- Various training programs
  - Lady Health Workers
  - Community Mid-Wives
  - Community Health Attendants
  - Community Health Workers
- Various levels of education and literacy
- Barriers to adequate training
  - Lack of trainers/materials
  - Low literacy

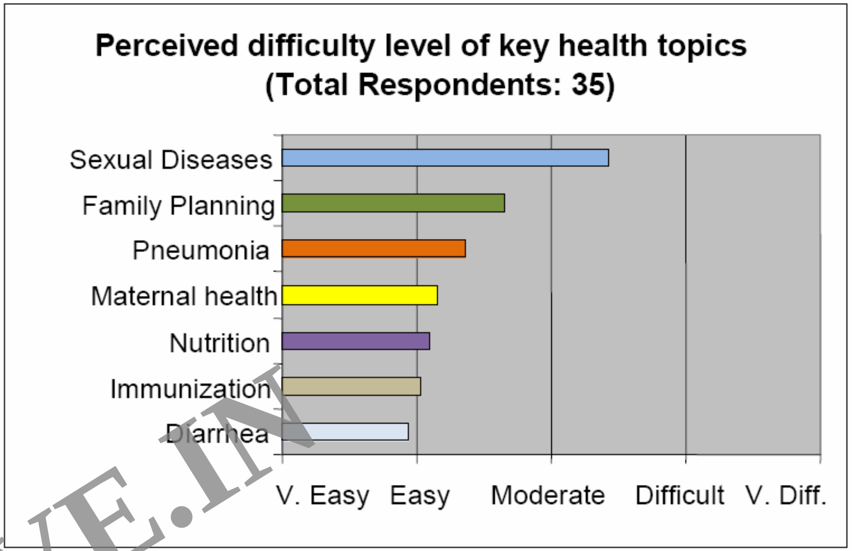
Health Worker Needs Assessment

TABLE I
HEALTH TOPICS CONSULTED IN THE MANUAL

Health Topic	Responses
Management of Diarrhea - e.g. dose of O.R.S.	5
Management of Pneumonia - e.g. dose of cotrimaxazole	3
Pregnancy care - e.g. what to do if a pregnant woman's BP goes high and she has asthma?	3
Family Planning - e.g. under what conditions should a woman abstain from taking injections for birth control	3
Hepatitis	1
Treatment of worms	1
Eclampsia	1
Delivery complications	1

TABLE II
PERCEIVED KNOWLEDGE GAPS

Topic	Requests
Hepatitis	18
Diabetes	12
Sexual diseases	10
HIV/AIDS	9
Deliveries	8
Antenatal Care	7
High blood pressure	5



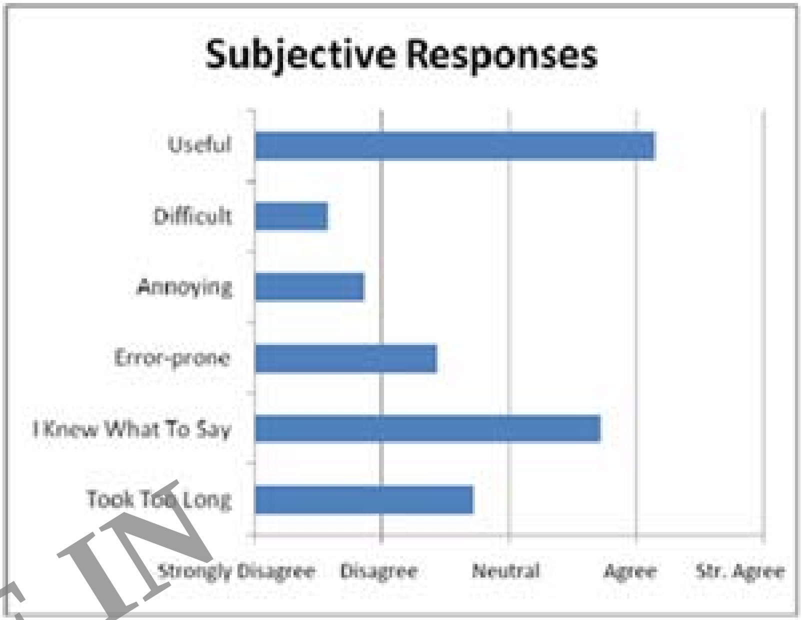
Tables and graph from Sherwani, J, et al. "HealthLine: Speech-based Access to Health Information by Low-literate Users." *Proceedings of International Conference on Information and Communication Technologies and Development* (ICTD 2007), Bangalore, India. doi:10.1109/ICTD.2007.4937399.

HealthLine Prototype

- Hello, I’m Dr Jameela, and I’m here to give you whatever health information you need. What topic do you want information on: Diarrhea, Pneumonia, or Important Messages for Health Workers?
- Diarrhea: This topic has 7 sections, when you hear the one you want, just say it: 1 What is Diarrhea [pause], 2 Causes of Diarrhea [pause], …, 7 The Third Principle of Treatment.
- What is Diarrhea? Diarrhea is a …[continues to the end of the section]. To hear this again, say “repeat”; to choose a different section, say “different section”, or for a different topic, say “different topic”. If you’re done, say “goodbye”.

Pilot Study

- 9 CHWs → 6 CHWs (3 not fluent in Urdu)
- 5/6 able to hear and report information from the system
- Technical difficulties
- Subjective analysis



Graph from Sherwani, J, et al. "HealthLine: Speech-based Access to Health Information by Low-literate Users." *Proceedings of International Conference on Information and Communication Technologies and Development* (ICTD 2007), Bangalore, India. doi:10.1109/ICTD.2007.4937399.

Future Directions

- Increase knowledge on what health workers have been trained on
- Provide new knowledge beyond training
- Keyword search abilities
- Evaluate for low-literate users

Conclusion

- Good system design approach?
- Good system evaluation approach?
- Advantages of speech system over GUI?
- Other interfaces for low literate users?

MAS.965 / 6.976 / SP.716 NextLab I: Designing Mobile Technologies for the Next Billion Users
Fall 2008

TECHNOLOGIES FOR CLINICALLY RELEVANT PHYSIOLOGICAL MEASUREMENTS IN DEVELOPING COUNTRIES

Paper by **Robert A Malkin, Department of Biomedical Engineering, Duke University.**

Published 19th July 2007

World map of disease prevalence removed due to copyright restrictions.

*****Presented by Sameer Hirji *****

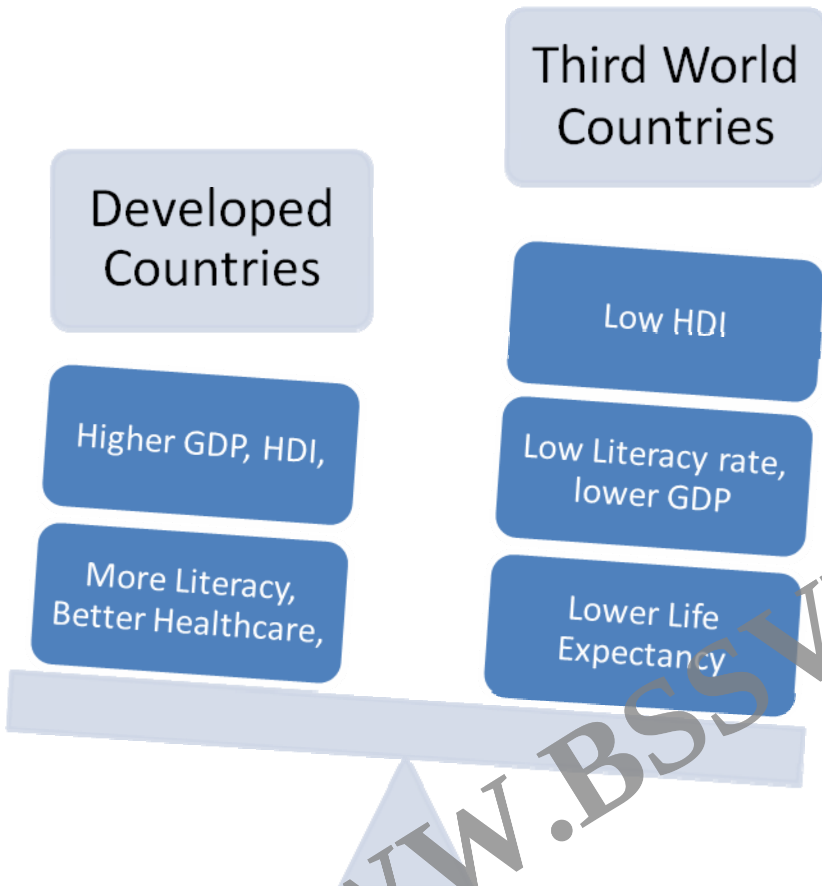
Focus Areas

- ✓ **Bottlenecks** in Developing counties

- ✓ **Factors for successful implementation** of Health care Technologies
  - Capital cost
  - Spare parts
  - Consumables
  - Embedded Service Contracts
  - Brain Drain Syndrome
  - Myths and Misconceptions

- ✓ Role of **CURE (Competition for Underserved, Resources-Poor Economies)** as a blueprint for Success. *"A not-for-profit business plan competition that develops new medical devices that specifically target unique needs of people in developing countries."*

Comparison of Bottlenecks



Statistical Data (WB 2001)

- *Of 5 Billion people in LDC's*
  - *1 Bn illiterate*
  - *1 Bn Lack Safe water access*
  - *2.5 Bn poor sanitation*
- *Avr. Life Expectancy in LDC is 38 yrs compared to greater than 75 yrs in Developed Countries*
- *GDP per Capita spent on Health is < $100 compared to $4000 in USA and $2000 in Europe*
- *Increased Excellent private Clinics / Hospitals in LDC's since 1991.*

"BUT WHY IS LIFE EXPECTANCY SO LOW?"

Barriers to Health Care Technology based on EWH Survey

- **High Capital Cost** e.g. Single MRI machine can cost US$10 000 000, or about 0.5 % GDP of Sierra Leone (compared to 0.0001% of US GDP), reliable power and electricity

  - Solution: Donation of Used Machinery, Foreign Govt Funding, Govt Expend.

  - **Problems??????**

- **Embedded Service Contracts and Spare Parts** e.g. Need regular maintenance due to frequent use (Flow Cytometers) , Lack of replacement parts (12.3%) , expensive, Experts to repair, No manuals, no specialized Equipment training

- **Consumables** e.g. No potential for reuse, LDC's have low budget ($0.30 per patient), Equipment specific items, non- functional/idle equipments, transportation costs

- **Brain drain Syndrome**: Skilled staff move to developed countries

QUES: How do we tackle this issue? What measures do we need to take?

Blueprint for Success

- **Physiological Measurements-** important tool for diagnosis and treatment
- **Alternate Designs** should avoid consumables, require little specialization, no extensive infrastructure, require infrequent service
- Development Initiative by **Duke-EWH CURE (One of the largest in the country)**
- **WINNER** receives **$100 000** for a year of incubation in Pratt School of Eng.
- **Process Involves:**
  - Needs Assessment through on the ground market research in Developing Countries **(Customer)**
  - Non- profit business development with national panel of experts **(Business Plan)**
  - Develop **prototype** through formal design class.

MIT OpenCourseWare
http://ocw.mit.edu

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Fall 2008

Speech Interfaces for Equitable Access to Information Technology

Review of a low cost, scalable, speech-driven application providing agricultural info to rural India's farmers.

Anastasios Dimas

Images from Plauché, Madeline and Udhyakumar Nallasamy. "Speech interfaces for equitable access to information technology." *Information Technologies and International Development* 4, no. 1 (2007): 69-86. Courtesy of the USC Annenberg School of Communications.

Speech Interfaces or Spoken Dialog systems (SDS)

Input: Speech → **SDS** Interface using **ASR** (Automatic Speech Recognition) **Interpreter** → Output

Key Word (s)

Automated Telephony

Pros:

•enhancing access to IT services for the visually or mobility impaired by replacing / enhancing traditional computer input (mouse, Keyboard) and output (screen).

Cons:

•Prohibitive cost of computing devices

•Required IT infrastructure

•Software design that assumes:

-literacy

-computer savvy

Speech Interfaces or Spoken Dialog systems (SDS)

Mobiles Phone applications in Rural India provide **info** on:

- Health
- Weather
- Employment
- News
- Agriculture

Pros:

- Affordable
- Infrastructure is more readily available
- Used extensively

Speech Interfaces or Spoken Dialog systems (SDS)

Challenges for SDS applications in rural India:

•Noisy Environment

•Multilingualism (over 420 languages spoken in India)

•Dialectal Variation (dialects change dramatically within a few hundreds of Km)

•Annotated corpora nor other costly linguistic resources exist for ASR use

•Design techniques developed for accessing sociocultural models developed for the Western world are not effective in poor communities

-Leisure & Formal education are spare

•Local content created by local providers is rare

-News

-Events

-Innovations

Radio and TV are less effective in influencing people to improve their practices in health agriculture etc than traditional oral methods of info dissemination

Speech Interfaces or Spoken Dialog systems (SDS)

Design Requirements for successful SDS:

Front-end dialogue interface should be:

•Interactive

•Easily adoptable

•Able to accommodate illiterate users

•Able to accommodate technology agnostic users

IT design and creation should involve community members. This ensures that:

•Proposed solutions meet community needs

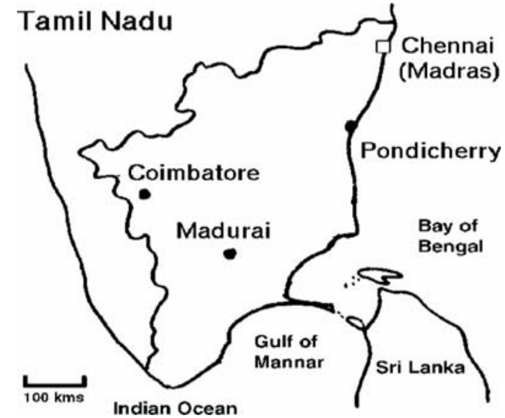
•The best chance for technological sustainability in the community is provided

•Community partners can provide accurate, locally created info to illiterate adults

-quickly

-cheaply

Speech Interfaces or Spoken Dialog systems (SDS)



Plauché and Nallasamy, 2007.

Tamil Nadu

37.47% of full time workers are farmers

71.64% of marginal workers are farmers

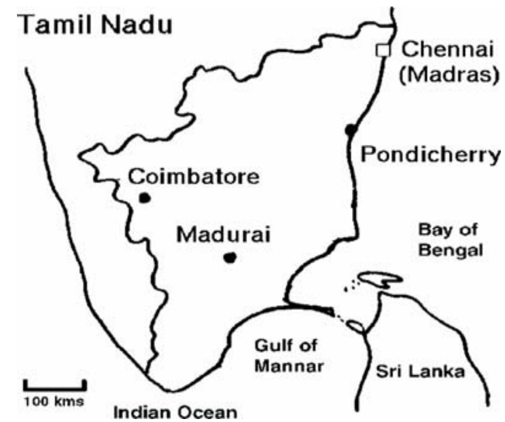
Overall 40% of the labor force in developing countries are farmers

Farmers' information needs:

- Price info (IT-based info networks can help raise the price of goods sold)
- Market info
- Techniques to improve production
  - Pest and disease prevention
  - New seeds

Speech Interfaces or Spoken Dialog systems (SDS)

MS Swaminathan Research Foundation (MSSRF)



Plauché and Nallasamy, 2007.

Pro-nature, pro-poor, pro-women NGO fostering economic growth in rural agricultural areas. Cooperated in the study.

Model:

Village VKC — "Knowledge worker" / Community member → Village Resource Centers

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Village Resource Centers (VRCs)
Act as **Local libraries** for:
- Agriculture
  - -Documenting crops
- Health
- Social issues
- Entrepreneurial Development

Hold:
- Meetings
- User registry
- Door-to-door surveys

→ **MSSRF HQ**

- Create content (audio video text)
- Training
- Video conferencing
- workshops

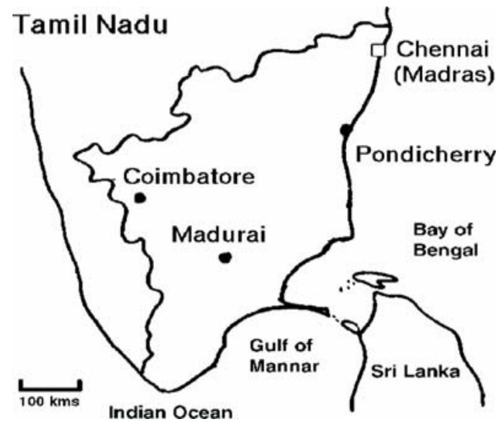
Info is

Consolidated
Digitized
Distributed

- Posted bulletins
- Loudspeaker Broadcasts
- 1-1 with KW

Phone | Dial up voice transfer | Wi-fi

Speech Interfaces or Spoken Dialog systems (SDS)



Plauché and Nallasamy, 2007.

ASR (Automatic Speech Recognition)

Algorithmically converts a speech signal into a sequence of words.

Hidden Markov Models* are trained on a large corpus of speech (training data).

Success depends on:

•the collection and annotation of the training data

•The creation of a dictionary of all possible words with all possible pronunciations in the language.

Success of 95% under optimal conditions:

•Controlled environment (quiet)

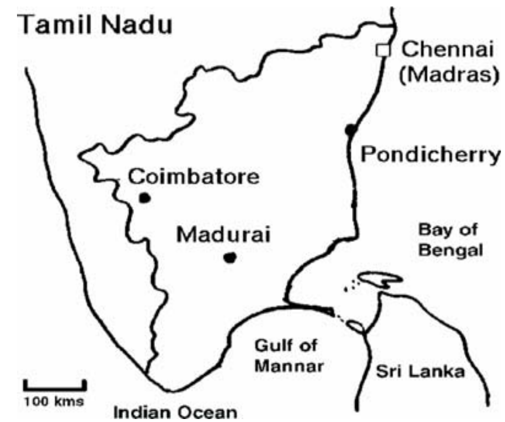
•Limited domain

•Single speaker

*A hidden Markov model (HMM) is a statistical mode in which the system being modeled is assumed to be a Markov Process with unknown parameters, and the challenge is to determine the hidden parameters from the observable parameters.

Speech Interfaces or Spoken Dialog systems (SDS)

ASR (Automatic Speech Recognition)



Plauché and Nallasamy, 2007.

Barriers:

To achieve human levels of recognition we require:

•Speaker-independent

•Large vocabulary

•Continuous speech recognition

These as a result lead to:

•cost of creating linguistic resources being prohibitive

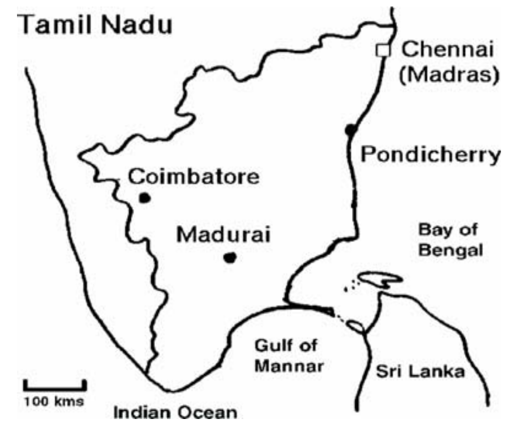
•Time dedicated to acoustic training data being vast (4-70 lifetimes)

•Too much expertise required to collect training data

Basic Principles of Speech Recognition Performance:

•The more data, the better
•The more input matches training data, the better
•The simpler the task, the better

Speech Interfaces or Spoken Dialog systems (SDS)



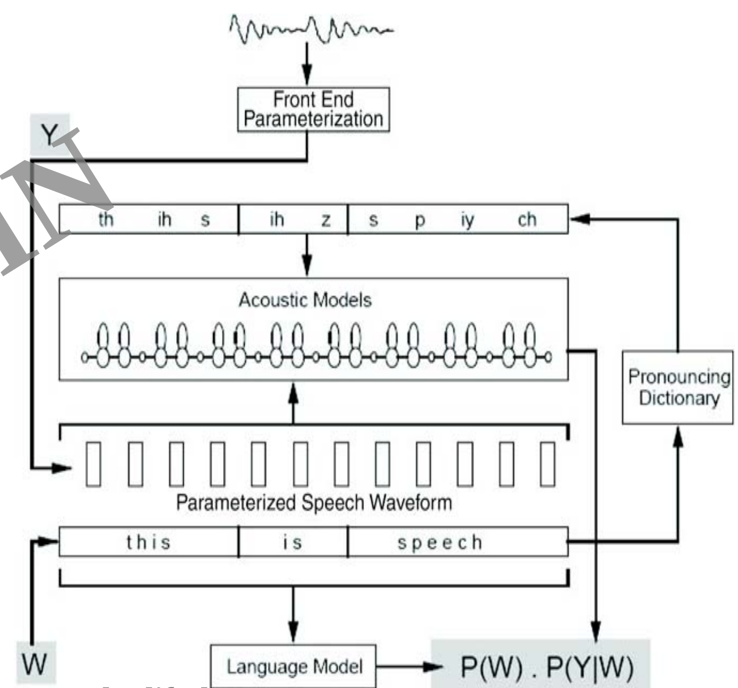
ASR (Automatic Speech Recognition)

Possible Solutions:

•Simplifying the recognition task

•Adopting adaptation techniques that tune the recognizer's models to match input data.

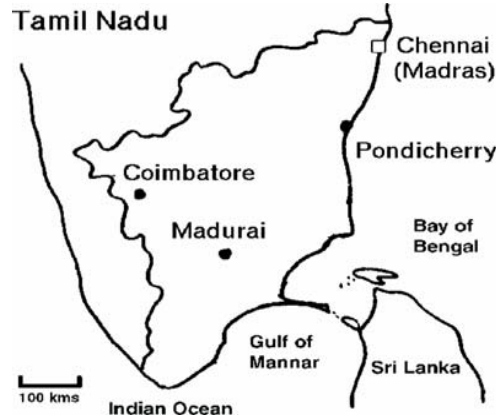
-leads to a minimal linguistic corpus required for acceptable error rates.



Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)

Field Study 1



•Speech recording of 77 rural villagers over 18 were conducted in 3 districts of Tamil Nadu (2004 -2005) to create adequate training data for machine recognition of a small vocabulary (<100 words). Gender education and age were balanced.

•Working alongside trusted organizations that serve the rural poor was the most efficient method for recruiting and recording villagers.

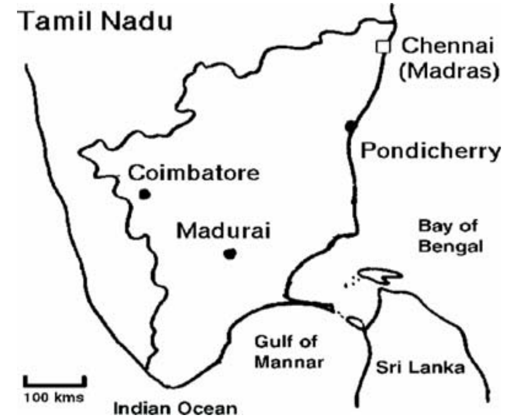
•2004 Data Collection: 30 words recorded in quiet offices via laptop and microphone

•2005 Data Collection: words for digits 0-10 using flashcards and a telephone handset with embeded microphone connected to Sony MD Walkman.

<u>Interesting facts:</u>
•data recordings from illiterate speakers took 6 times more!
•10000 speech samples extracted
•whole word recognizer trained on speech of 22 speakers using HTK (2004)

Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



Field Study 1

Experiment 1:

3 trials of varying complexity

•All words

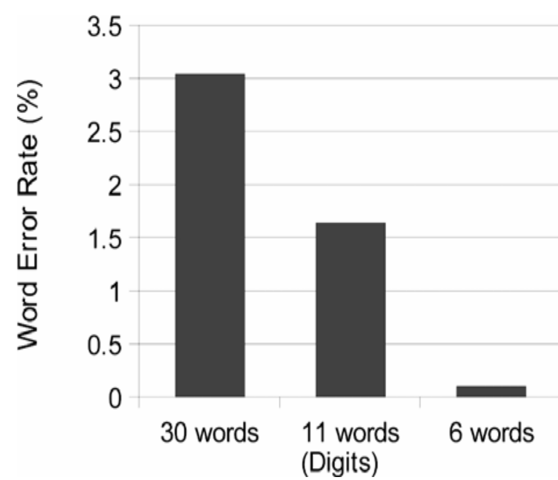
•Digits only

•6 command words

Results:

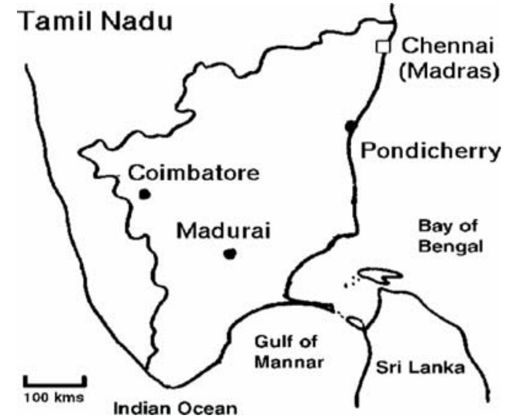
Word error rates dropped for tasks with fewer options for correct word identity. Overall error rate <2%.

An SDS of small vocabulary or limited word options per dialog node would require very little training data (<3hours) to achieve recognition



Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



Field Study 1

Experiment 2:

Goal: Evaluate influence of phonetic and lexical variations on a small vocabulary recognizer.

Recording words for digits in Tamil language in 3 different districts revealed that pronunciation of “7” and the choice of word for “0” varied significantly.

The trained recognizer on the speech of the 22 speakers of 2004, was used in the 3 districts of the study.

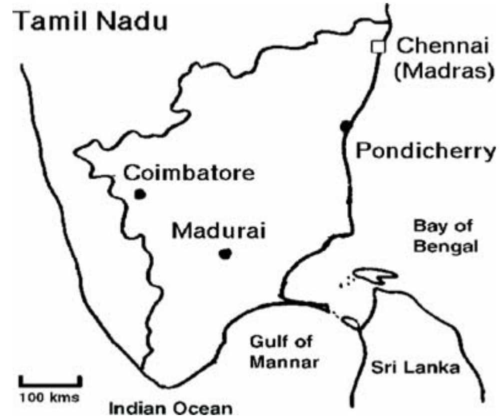
Results:

The study yielded significantly higher error rates than before.

This shows that SDS must be trained on speech from people who are potential users to ensure there will be no huge variations in dialect and choice of vocabulary between training speech and field data.

Map: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



Field Study 1

Experiment 3:

Goal: Determine the least amount of data needed to achieve acceptable error rates for the SDS operation via simulation.

a. Organizer was trained on 1 randomly selected speaker's speech in which a second randomly selected speaker's speech was used as input.

Results: word error rate =80%

b. Next the recognizer was trained on 2 randomly selected speakers' speech

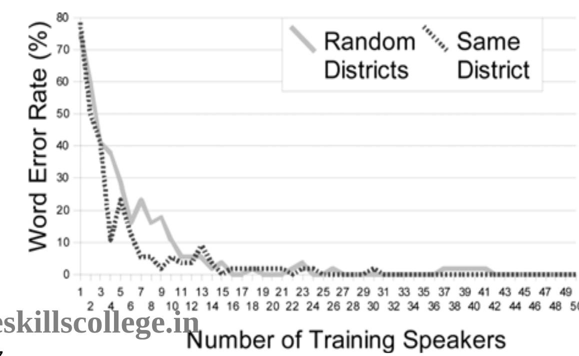
Results: word error rate dropped

c. Experiment was replicated under 2 conditions:

•More speakers were added randomly from all 3 districts.

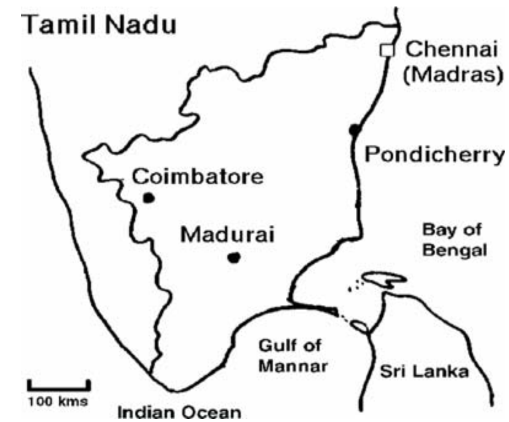
•Speakers from the test speakers district were added first.

Results: When less than 15 speakers are available for training, recognition for a given speaker is better if trained on speakers from the same district.



Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



Field Study 1

Overall results:

Errors decrease with

•simple tasks

•Matching input and training data

•With more training data

Proposals:

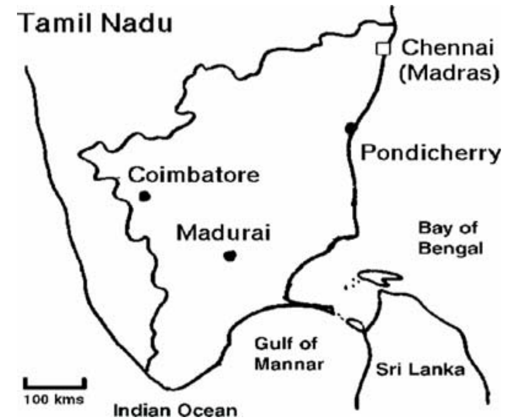
•SDS design should limit the complexity of the ASR task to approximately 10 words or fewer at any given dialog node.

•Speech collection should be integrated into the SDS design. Thus needs of the user and needs of the system are met simultaneously.

•ASR for each village could achieve adequate accuracy for SDS usability with the speech of only 15 speakers.

Map: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



UI Design

Overall Guidelines:

•Let users feel in charge

•Spare users as much effort as possible

•An appropriate and affective user interface is one that fits the task to be accomplished.

The nature of the task should dictate appropriateness of UI style, not the level of expertise of the user.

Speech UIs

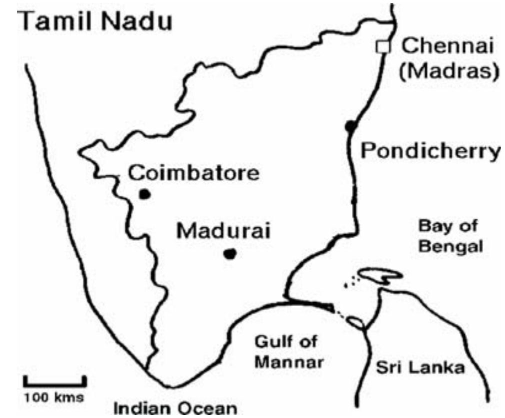
•Less expensive than display-based UI solutions

•More accessible than text-based UI solutions

•Voice feedback in the local language helps with user interest and comfort

Map: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



UI Design - Speech

Literacy:

•In Tamil Nadu, illiteracy rates are 50% for men, 80% for women.

•Information is primarily disseminated via word of mouth.

•Unschooled adults rely on empirical situational reasoning

•Design features considered to be intuitive (hierarchical browsing, icons representing items, etc) present a challenge to illiterate user.

Design Guidelines:

•Ease of learning

•No textual requirements

•Graphics (and possibly speech in local language)

•Support for internationalization

•Accommodates localization

•Simple, easy to use, tolerant of errors

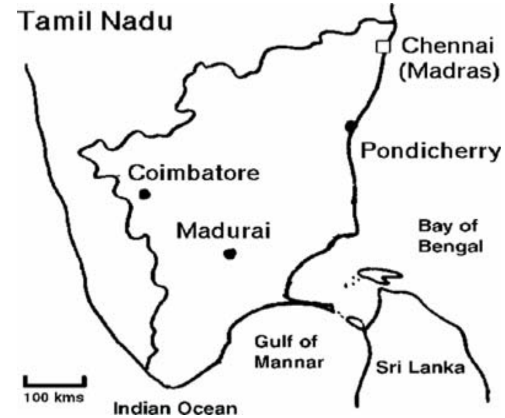
•Accurate content

•Robust in (potentially distracting) public places

Map: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)

UI Design - Speech



Localization:

For each language and culture the following UI elements are subject to change:

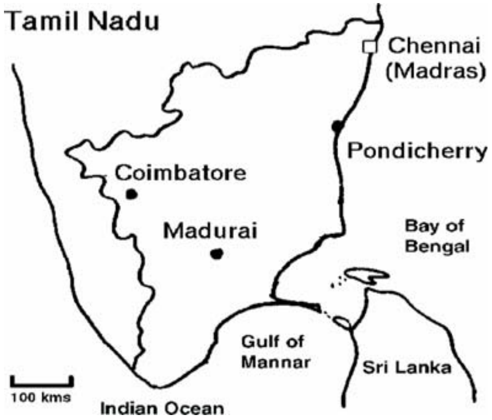
- Fonts
- Color
- Currency
- Abbreviations
- Dates
- Register
- Concepts of time and space
- Value Systems and Behavioral Systems

User study techniques such as questionnaires, storyboards and walkthroughs present difficulties for the illiterate due to their daily requirements and ambient infrastructure. **Successful UIs** should build on existing means of info transfer and existing linguistic and cultural expertise by enabling community authorship of content.

Map: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)

Field Study 2: OpenSesame SDS



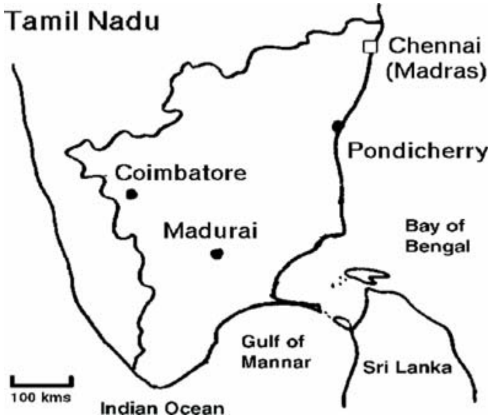
Experiment:

- Development of SDS template for creating multi-modal SDS
- Collaboration with MSSRF staff
- Goal: Port 1 unit (Banana crop) of the text-based Valam website to the interactive OpenSesame application.
- User studies conducted using live speech recognition in Dindigul region, Tamil Nadu
- Audio input recorded during user interactions with OpenSesame SDS served to simulate integrated data collection and ASR adaptation techniques.

Images: Plauché and Nallasamy, 2007.

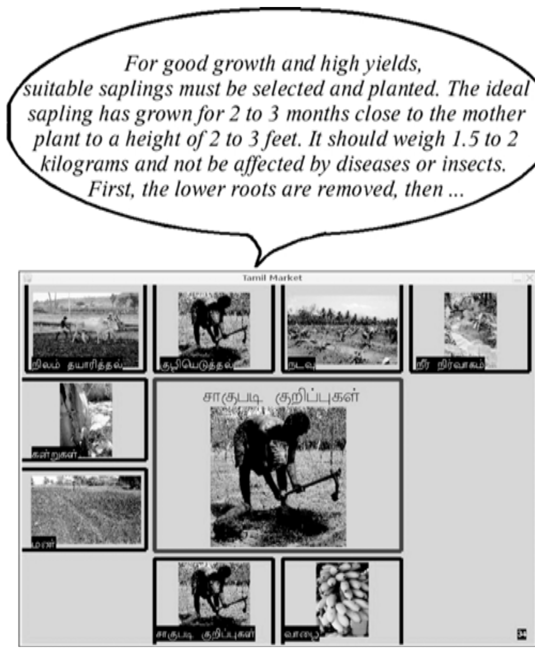
Speech Interfaces or Spoken Dialog systems (SDS)

Field Study 2: OpenSesame SDS



OpenSesame – Banana Crop Application

The application was a tool to educate the user via digital photographs and a narrative in Tamil on the recommended practices for growing, harvesting and propagating a banana crop according to local conditions and needs.

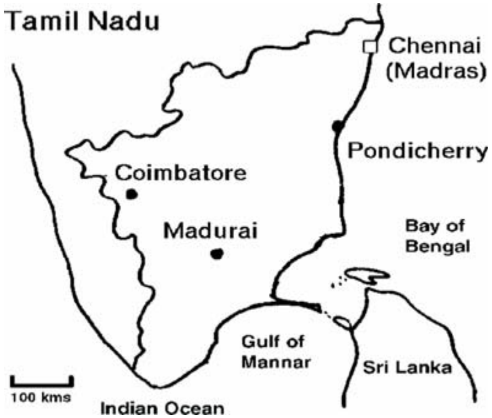


- Interactive UI that adhered to aforementioned guidelines
- Completed in less than 3 weeks:
  - -identifying appropriate content (sites, photos etc)
  - -varying the accuracy of the text version
  - -gathering digital pictures
  - -recording speech output
  - -synchronizing all elements
- Input: Speech and Touch screen
- Output: Graphics, small text, pre-recorded audio files

Images: Plauché and Nallasamy, 2007.

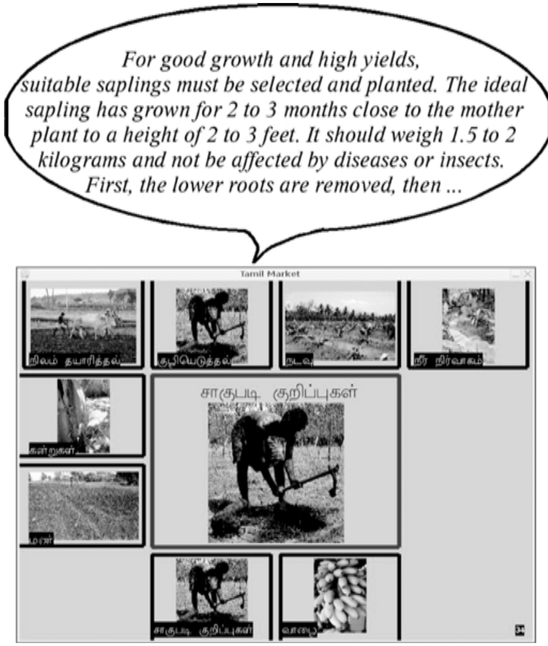
Speech Interfaces or Spoken Dialog systems (SDS)

Field Study 2: OpenSesame SDS



OpenSesame – Banana Crop Application

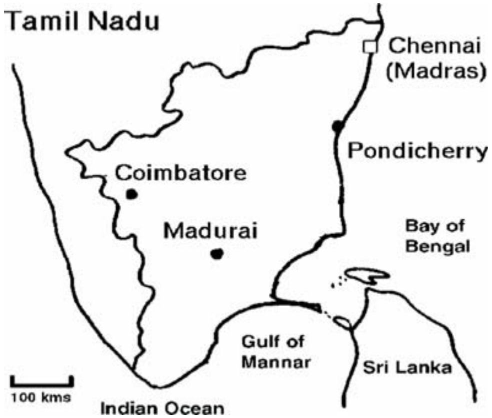
- 28 acoustically dissimilar and locally appropriate vocabulary words were selected to correspond to the Valam site subheadings
- Menu system was only 3 levels deep
- No more than 8 options at a time were presented
- The system was highly redundant when no input was provided
    - -listing options at every screen
    - -disseminating info in the form of audio slide show



Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)

Field Study 2: OpenSesame SDS



OpenSesame – Banana Crop Application ASR

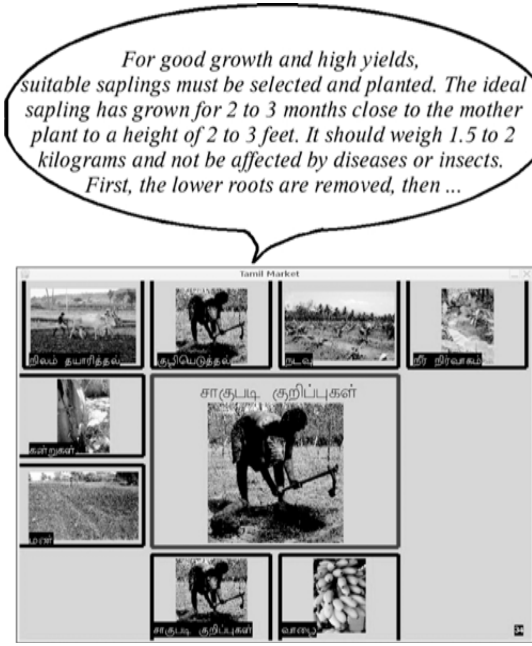
Requirements:

- Recognize multiple speakers
- Be robust to noisy conditions under limited linguistic data

Design:

- The ASR was trained in Tamil speech recordings used in Field Study 1,
- built using the HTK
- Pronunciation dictionary was prepared along with its phonemic representation (sub-word level) allowing to accommodate new words and phonetic contextual variations
- Test database was prepared by recording 5 MSSRF members

  -Triphone models (single Gaussian) performed at 97% accuracy



Images: Plauché and Nallasamy, 2007.

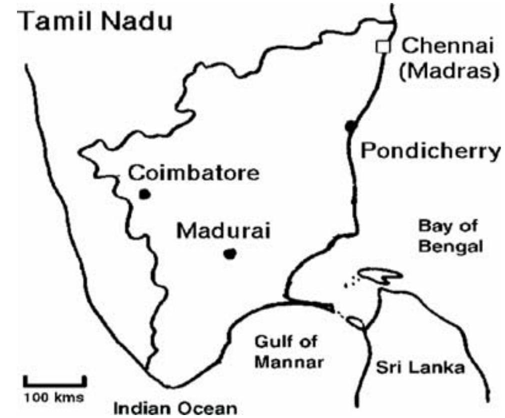
Speech Interfaces or Spoken Dialog systems (SDS)

Field Study 2: OpenSesame SDS

OpenSesame – Banana Crop Application ASR

Field evaluations:

- System was evaluated by 50 people in 3 different conditions across 6 different sites
- 200 more people were onlookers
- Participant's audio commands to SDS were recorded during use
- Sessions were sort
- Involved little training
- Informal feedback was requested (content ease of use, preferred modality (audio/touch-screen))

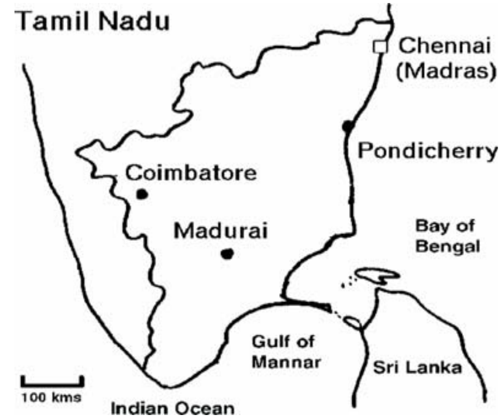


Conditions	Users	Site Description
Controlled user study	3 men (literate)	Sempatti VRC: • One user at a time • Group feedback • 30 min. sessions • Speech only
	8 women 5 men (literacy varied)	Panzampatti VKC: • One user at a time • Individual feedback • 10–20 min. sessions • Speech and touch
Farmer focus group	15 women 20 men (literacy varied)	S.Kanur: • Group use • Group feedback • 5 min. sessions • Speech and touch
	10 women 20 men (literacy varied)	Gandhigram: • Group use • Group feedback • 5 min. sessions • Speech and touch
Village outreach	5 men (literacy varied)	Athoor: • One user at a time • Group feedback • 10 min. sessions • Speech only
	8 men 4 women (literacy varied)	P.Kottai: • One user at a time • Group feedback • 10-min. sessions • Speech only

Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)

Field Study 2: OpenSesame SDS



OpenSesame – Banana Crop Application ASR

Results:

•Input categories:

-N/A: empty sound files/ no speech/ background speech (23% success- silence recognition)

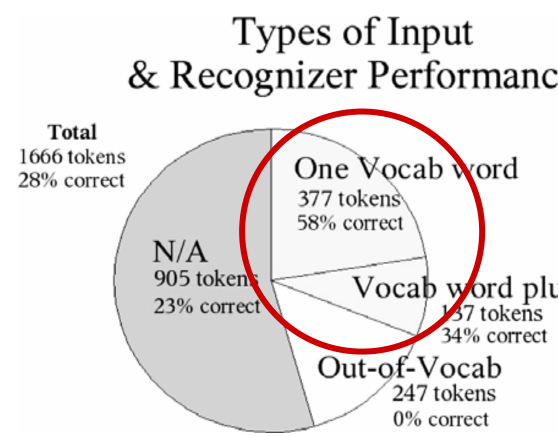
-Out-of-vocab:15% of input were utterances directed to SDS but not included in ASR's vocabulary (0% success)

-One vocab word: contained 1 ASR vocabulary word (58% success)

-Vocab word plus: 1 ASR vocabulary word + other non-vocabulary word/speech (34% success)

•Recognition performance on isolated words was much worse during SDS interactions (58%) than that of MSSRF staff (97%):

Dissimilarity probably due to difference in speaking style (reading aloud / issuing commands to a machine)

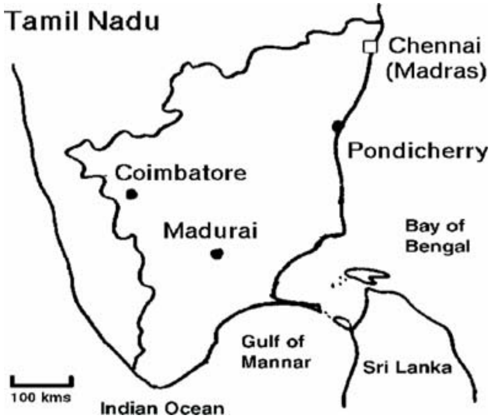


One vocab word + Vocab word plus input was <30% of total input

Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)

Field Study 2: OpenSesame SDS



OpenSesame – Banana Crop Application ASR

Results:

•Recognition performance by site revealed that social and environmental factors affect performance

-Controlled user study with literate subjects yielded high performance (highest)

-A not well-controlled user study with illiterate subjects yielded low performance (lowest)

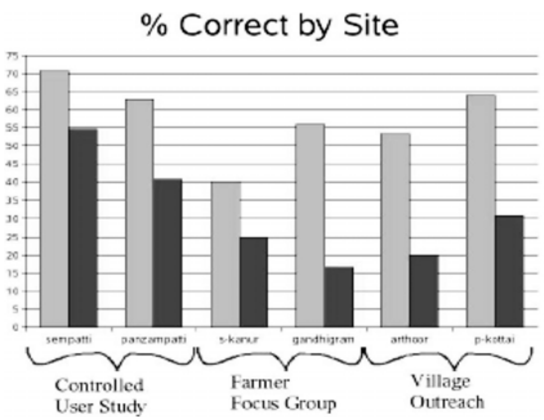
•Participants reported that the interface was easy to use

•Educated participants commented that the system would be “good for people who cannot read”.

•Some subjects preferred speech as a means of input, while others speech

•Many corrections and suggestions were proposed for the SDS, such as the addition of more crops to the system

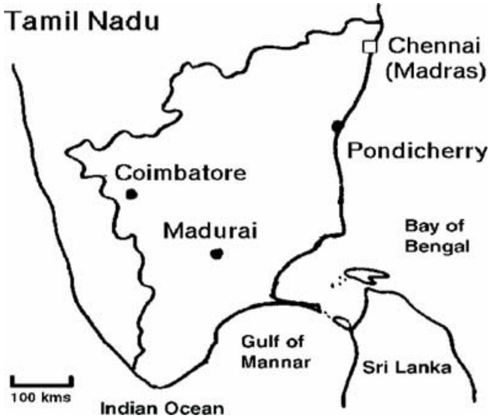
•MSSRF staff played a key role in the evaluative sessions



Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)

ASR Adaptation



Images: Plauché and Nallasamy, 2007.

A technique for automatically or semi-automatically optimizing a recognizer by gradually integrating new, untrascribed data into the models for speech.

Fact:

•Only 3 speech technology efforts have been directed to Tamil which is spoken by 60 million people.

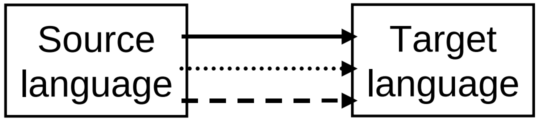
Techniques to overcome this barrier:

•**Cross-language transfer**: When annotated corpora is not available (as in Tamil) an ASR trained on transcribed data from one or more (source) languages can be used to recognize speech in the new (target) language.

•**Language adaptation:** ASR trained on a large source language corpus and then the acoustic models are adapted to a very limited amount of target language data. (depends on # speakers + data).

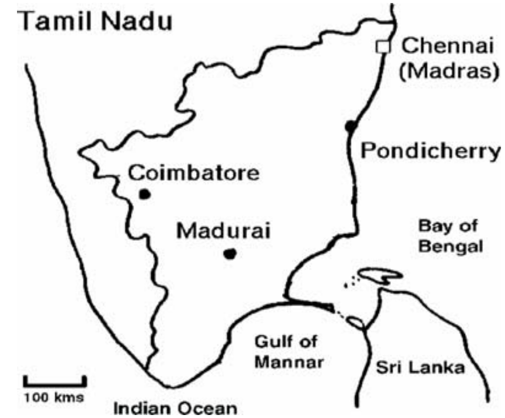
•**Bootstrapping**: Acoustic models are initialized from a small amount of transcribed source data. The ASR is then iteratively built, using increased amounts of training data and adaptation.

Adaptation Technique	Availability of Data
Cross-language Transfer	No data
Language Adaptation	Very limited data
Bootstrapping	Large amounts of data



Speech Interfaces or Spoken Dialog systems (SDS)

Experiment 4:



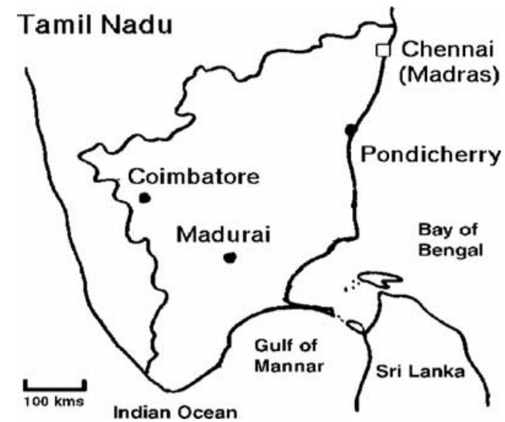
Goal: How to optimize the small vocabulary recognizer to the speech of a particular community given no or limited Tamil training data.

- Use of speech collected during **Banana Crop Application**
- Use of **Cross-language transfer** and **Language adaptation**
- Databases used: SDS Tamil 2006 /Tamil 2006/Tamil 2005/ English TIMIT

Data Set	Size	Dictionary Size	Description
SDS Tamil (2006)	Very small (377 words)	Very small (28 words)	Agricultural words spoken by villagers retrieving information from Banana Crop SDS indoors and out in Dindigul district
Tamil (2006)	Very small (170 words)	Very small (28 words)	Same agricultural words read out loud by MSSRF staff in a fairly quiet office in Dindigul district
Tamil (2005)	Small (10K words)	Very small (50 words)	Digits and verbs read or guessed out loud by speakers of all literacy levels indoors and out in three districts
English (TIMIT)	Medium (50K words)	Medium (6K words)	Phonetically balanced sentences read out loud in a quiet laboratory setting

Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



Experiment 4:

Process:

•In the field, the recognizer trained on the Tamil 2005 database recognized commands for Banana Crop SDS with 58.1% accuracy

•Substantial improvement in accuracy (68.7%) occurred via:

-the collapse of certain contrastive phonetic categories (long vs. short vowels)

-the addition of noise robustness method (cepstral mean subtraction) to factor out environmental noise and generalize across tasks and speakers.

•**Cross-language transfer:**

-Tamil phonemes were mapped to English as closely as possible

-Training and decoding were performed using HTK

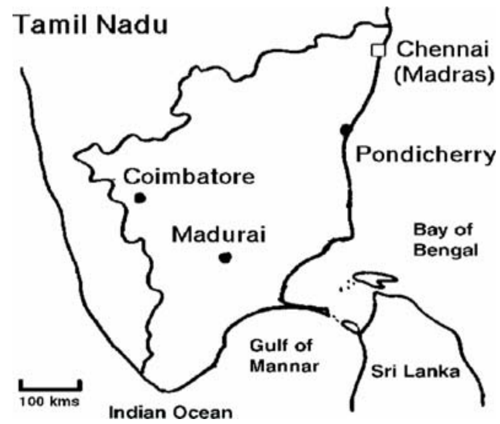
1.Acoustic models are trained with a default flat initialization

2.Triphone models are developed based on monophone HMMS and the ASR decodes using a simple finite state grammar.

Results:
Tamil SDS powered by English recognizer had 30% accuracy

Conclusion:
Its better to train on a small amount of same language data than on a greater amount of mismatched data

Speech Interfaces or Spoken Dialog systems (SDS)



Experiment 4:

Process:

•Recognizers were initialized on either English or Tamil and then the recognizer was adapted to the Tamil 2006 database (5 volunteers **-1 hour recording**); maximum likelihood linear regression was used.

-Adaptation to Tamil 2006 improved the performance for both the recognizer trained in English and the recognizer trained on Tamil (82.2% and 80.4% accuracy rates respectively).

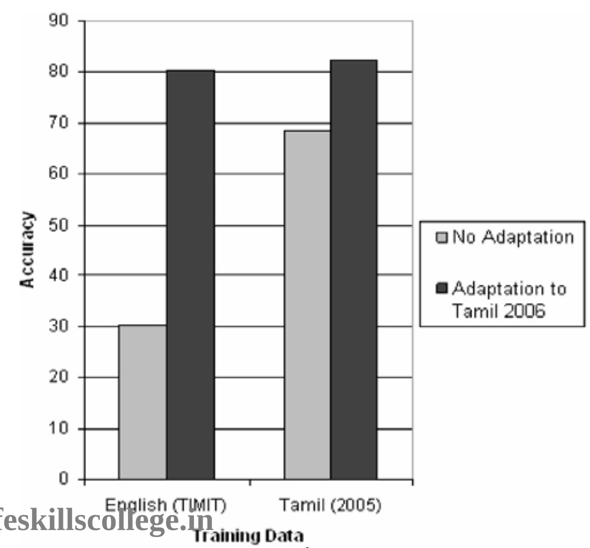
Conclusions:

•It is more sensible to use an existing English trained system with a small database (like Tamil 2006) than to use a larger database such as Tamil 2005 (**100 hours of recording**) if they are to yield similar results (**82.2% , 80.4%**). It overcomes **recording costs.**

•**Other methods of ASR adaptation mentioned:**

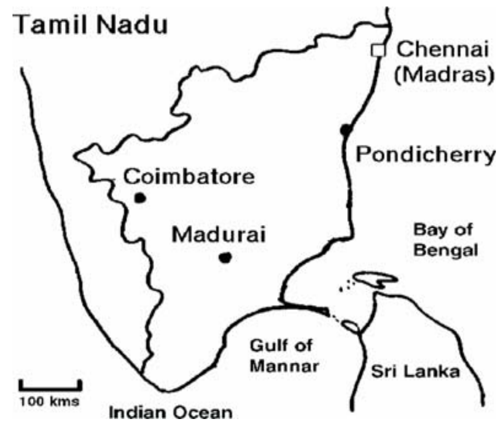
-Supervised adaptation

-Unsupervised adaptation



Images: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



Future plans and overall conclusions:

•We reviewed Speech technologies and techniques that are:

-small

-scalable

-easy to modify and update by local stakeholders

And that can be constructed to deliver:

-accurate

-locally relevant

information to individuals regardless of their literacy level

•**Integrated data collection** and **language adaptation** are found to be useful techniques for collecting linguistic resources according to user needs and system needs

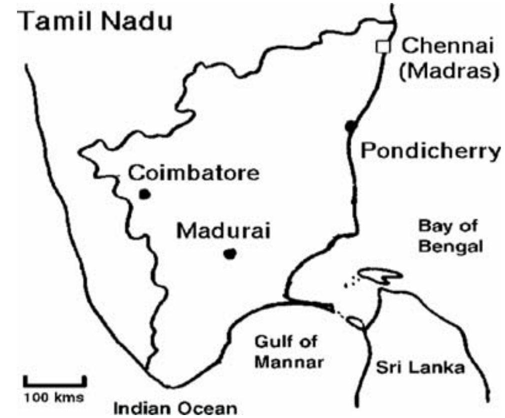
•**Future tasks:**

-determine the minimum amount of adaptation data required to reach adequate levels of ASR accuracy

-develop speech/no speech detectors and out of vocabulary models

Map: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)



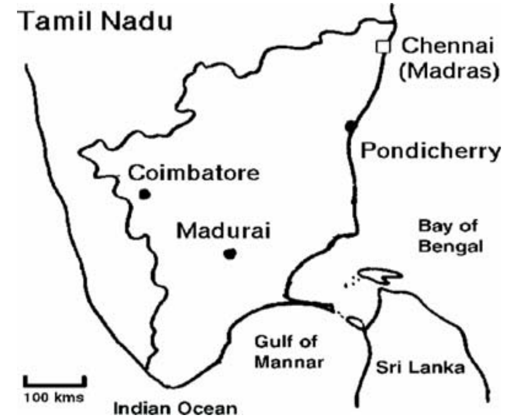
Questions:

- **Ways of increasing the one vocab + "space solution"?**
- **Other ASR adaptation techniques?**

Map: Plauché and Nallasamy, 2007.

Speech Interfaces or Spoken Dialog systems (SDS)

Thank you



Map: Plauché and Nallasamy, 2007.

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Diagnostic accuracy of chest X-rays acquired using a digital camera for low-cost teleradiology

Agnieszka Szot, Francine Jacobson, Samson Munn, Darius Jazayeri, Edward Nardell, David Harrison, Ralph Drosten, Lucila Ohno-Machado, Laura Smeaton, Hamish Fraser

Problem

A

B

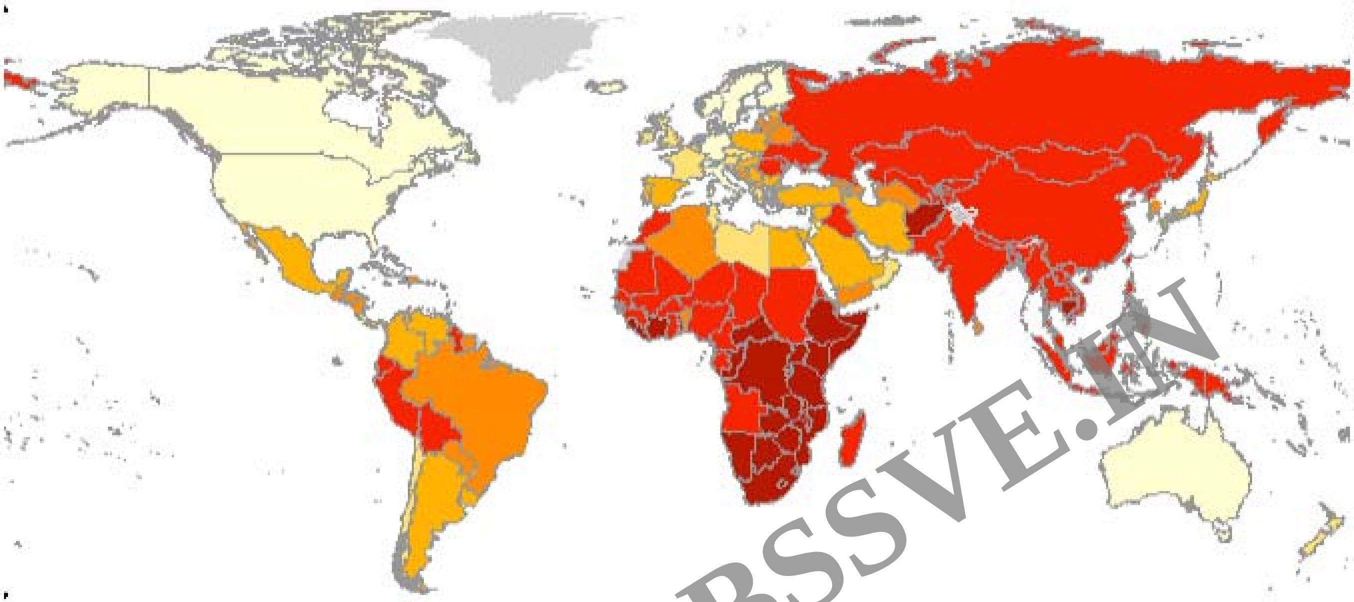
Two chest x-ray images removed due to copyright restrictions.

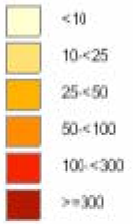
Source: emedicinehealth.com

Source: studentBMJ 2000;08:303-346

Incidence of TB

Communicable Diseases -> Tuberculosis (as of 22 March 2006) -> Estimated TB -> Estimated TB incidence --> TB incidence, all forms (per 100 000 population per year), Total, Max of all Periods, 2004
Source: WHO Stop TB Department, website: www.who.int/tb





Prevalence of Physicians

Country	Doctors/100,000 people
▪ US	279
▪ South Africa	56.3
▪ Peru	93.2
▪ Haiti	13

14 countries in Africa have 0 radiologists

Solution

- Store-and-Forward Telemedicine

- Take digital photo of Chest X-ray
- Edit
- Compress file
- Email photo with text to physician
- Wait for DX

Research

- What is the most compressed image format that can be used that still allows for reliable diagnosis of TB?

- Compared DX of

  Original image

  JPEG ~ 400 KB

  JPEG2000 ~ 98-120 KB

Results

- JPEG and JPEG2000 images were diagnosed similarly to the original images.
- Overexposure in the digital processing actually increased detection of calcifications

Highlights of Paper

- Good understanding of medical imaging
  - Gray-Scale
  - Window and Level
  - Exposure
- Good understanding of TB DX
- Study did not use top-end cameras

Questions

How do you think results would change if study had been performed in the field and not Boston?

What context does your own project take place in and how can you use that to your advantage?

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Localized Iterative Design for Language Learning in Underdeveloped Regions: The PACE Framework

Kam, Ramachandran, Devanathan, Tewari, Canny

By anonymous MIT student

Paper Overview

- Aim – explore game-like language learning on cell phones
- PACE Framework
- Design and Implementation
- Experiences in Usability and Learning
- Questions

"Language divide"

- Originally motivated by concerns about a "digital divide"
- 90% of the indigenous web content in India is in English
- Desire among low income population to improve command of a "world language"
- Fluency opens outsourced job opportunities, access to govt. health and legal services

Challenges with English as a Second Language (ESL) learning

- Irregular school attendance
- Disinterest – perceived opportunity costs, lack of benefits
- Local ESL teachers

Image: CIA World Factbook

Computer-assisted (cell phone) learning interventions

- "... how can we co-design applications with community partners that meet their local language learning needs, without incurring content development costs that are beyond the budgets of community development projects?"

- Accurate understanding of user's baseline education
- Take into account limited computing experience
- Stakeholders and designers may not share common cultural backgrounds

Iterative design

- Step 1 : Field studies (July 2004-05)
  - Interaction with rural school children
  - Assess usability problems
  - Personas of the children, everyday life scenarios
- Step 2 : Design based on PACE framework
  - PACE process streamlines the cost of repurposing existing learning resources for new audiences
  - Review curriculum
  - Design modifications based on user study results

PACE : Pattern-Activity-Curriculum-Exercise

- Pattern

Pattern name: Written Word->Semantics Association

Problem: vocabulary building, word recognition

Solution:

Suppose X=4:

1. Displays a word and also displays its meaning pictorially. As an optional step, the meaning of the word can also be conveyed orally and/or textually in the learner's native language
2. Repeat step 1 for X-1 more times
3. Displays one of the X words that was previously displayed during steps 1-2
4. Presents the learner with at least X pictures to choose from, and provide learner with feedback on whether or not his choice was correct or incorrect
5. Repeat steps 3 and 4 for X-1 more times

(Steps 1–2: Receptive Phase; Steps 3–4: Activation Phase)

To reduce level of difficulty:

- read aloud the word in step 3 to the learner, so as to help him learn to decode it

To increase level of difficulty:

- steps 1 and 2 can be omitted
- X can take on a higher value
- the sequence of the X pictures presented in step 4 can be randomized each time step 4 is repeated
- limit amount of time learner is given in step 4
- replace the word in step 1 with a phrase or sentence

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PACE

- Activity

Image removed due to copyright restrictions.

Four-step sequence of cell phone screen photos, demonstrating the "Written Word → Semantics Association" design pattern. See Fig.2 in Kam, M. et al. (2007) "Localized iterative design for language learning in underdeveloped regions: the PACE framework."

Design and Implementation

- Patterns
  - Balance of listening, reading, speaking, writing skills
  - Derived from common ESL teaching methods
- Activities
  - Prototyped on the .NET CF platform, high end phones
  - Aimed at facilitating user-interface learnability
  - Avoid overwhelming the player with too much material at once
  - Situated in fantasy settings

Cultural context driven activity

Image removed due to copyright restrictions.

Two-step sequence of cell phone screen photos, demonstrating the "phoneme → grapheme association" design pattern. See Fig. 3 in Kam, M. et al. (2007) "Localized iterative design for language learning in underdeveloped regions: the PACE framework."

- Player was assumed to have learned an item only if she was tested on it until she was correct thrice

Design and Implementation

- Curriculum & Exercise
  - culturally appropriate words
  - covered English alphabet, numbers, dates & times, social situations, shopping, traveling
  - Hindi voiceovers

Feedback

Word-picture matching not always effective in practice

Using the native language to teach a second language is a controversial point among language instructors

User Studies : Usability and Learning

- Overall very engaging
- Initial problems using the joystick button
- Modified based on suggestions from NGO partner/ native informant
- Games were appealing until the atmosphere became competitive

Challenges with localization

- Not easy to think of graphics that intuitively conveyed what their corresponding words meant (particularly in the local context)
- The team quickly incorporated changes based on feedback during testing
- How quickly can children in an underdeveloped region who have never used cell phones learn to use them?

Hole-in-the-Wall Project

Courtesy of Hole-in-the-Wall Education Ltd. Used with permission.

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Issues with localization?

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Worms: Education and Health Externalities in Kenya

Michael Kremer and Edward Miguel
Poverty Action Lab Paper No.6
Sept 2001

Presented By:
Anonymous MIT student

Objective

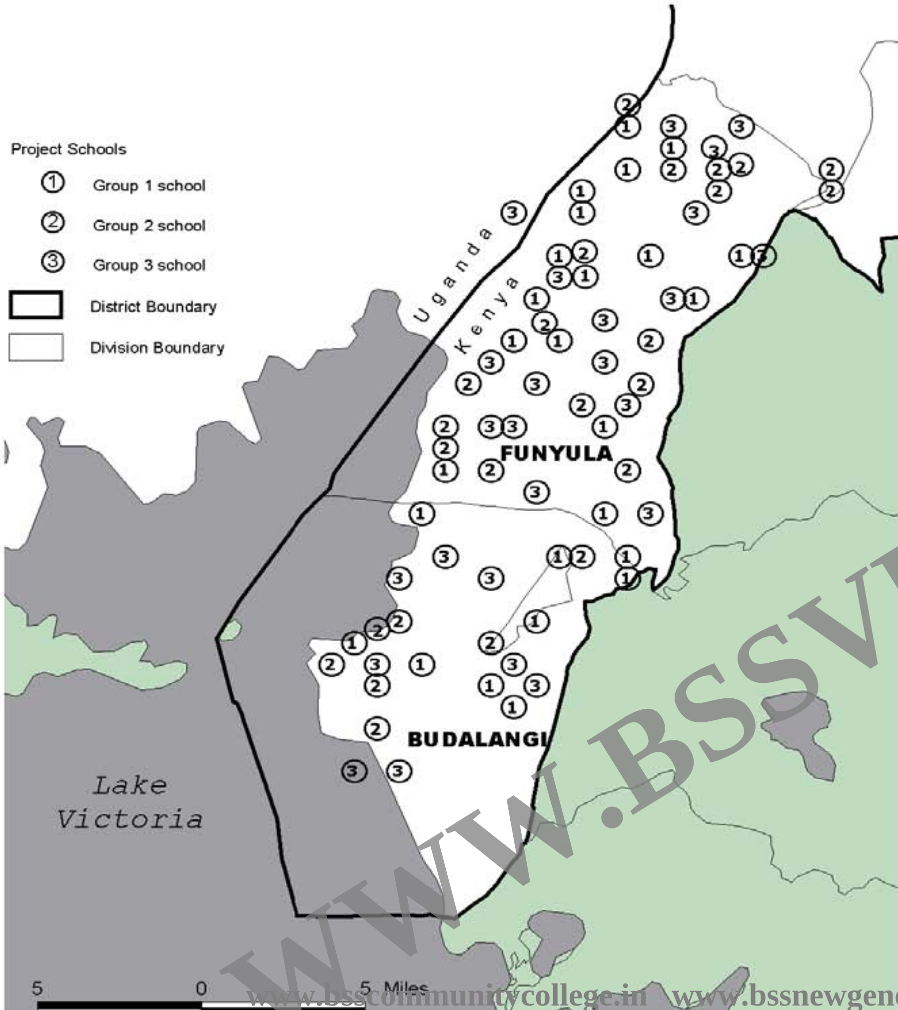
- Health (Worms) → Education (School Participation)
- To evaluate the effect of a school-level randomized deworming treatment on primary school participation by boys and girls under age 13

- Key words:
    - **Randomization** – program participation not correlated in expectation with either observed or unobserved individual characteristics
    - **Externalities** – impact on any party not directly involved in the economic decision

Worms - Background

- 3.7 billion people are infected by Intestinal Helminth (roundworm, hookworm. schistosomiasis)
- Infection rates highest amongst school-age children in Sub-Saharan Africa
- Transmission
  - contact with or ingestion of infected fecal matter
  - Infected freshwater streams or lakes (Lake Victoria)
- Effects
  - Anemia, stunting, protein energy malnutrition
- Treatment
  - Low-cost single-dose oral therapies (Albendazole, Praziquantel)

Primary School Deworming Project in Busia, Kenya



- How is randomization used in the experimental setup?

Courtesy of Michael Kremer and Edward Miguel. Used with permission.

Experimental Design

- Treatment vs Control Groups
  - What might be the difference between *within school* treatment and *across school* treatment?
- Measuring effects
  - What are some of the ways you can measure effect of treatment? Is school participation okay? What else is there?

Results

- What is obvious to expect?
  - Naïve treatment effect
  - Health Externalities

Table 6: The direct health impact of deworming, January to March 1999, Group 1 schools (1998 Treatment) versus Group 2 schools (1998 Comparison)[51]

	Group 1	Group 2	Group 1 – Group 2
Any moderate-heavy infection, 1998	0.38	-	-
Any moderate-heavy infection, 1999	0.27	0.52	-0.25*** (0.06)
Hookworm moderate-heavy infection, 1999	0.06	0.22	-0.16*** (0.03)
Roundworm moderate-heavy infection, 1999	0.09	0.24	-0.15*** (0.04)
Schistosomiasis moderate-heavy infection, 1999	0.08	0.18	-0.10* (0.06)
Whipworm moderate-heavy infection, 1999	0.13	0.17	-0.04

Table 8: Deworming health externalities across schools, January to March 1999[54]

	Dependent variable:				
	Proportion any moderate-heavy helminth infection	Proportion moderate-heavy schistosomiasis infection			Proportion moderate-heavy geohelminth (hookworm, roundworm, whipworm) infection
	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)
Indicator for Group 1 (1998 Treatment) School	-0.24*** (0.05)	-0.06 (0.04)	-0.11 (0.21)	-0.05 (0.04)	-0.24*** (0.05)
Group 1 pupils within 3 km (per 1000 pupils)	-0.12** (0.05)	-0.09** (0.04)	-0.13** (0.06)	-0.21** (0.10)	-0.05 (0.06)
Total primary school pupils within 3 km (per 1000 pupils)	0.00 (0.05)	-0.02 (0.04)	0.00 (0.05)	0.06 (0.05)	0.06 (0.06)
Group 1 pupils within 3-6 km (per 1000 pupils)	-0.08* (0.05)	-0.09** (0.04)	-0.08 (0.08)	-0.27*** (0.07)	-0.02 (0.05)
Total primary school pupils within 3-6 km (per 1000 pupils)	0.06 (0.05)	-0.02 (0.04)	-0.03 (0.05)	0.09* (0.05)	0.12** (0.05)

Effects on School Participation

- Girls <13 years of age and all boys versus Girls>=13 years of age?
- Grades 1-2 versus Grades 7-8?

Table 9: School participation, school-level data[55]

	Group 1 (25 schools)	Group 2 (25 schools)	Group 3 (25 schools)		
First year post-treatment (May 1998 to March 1999)	*1st Year Treatment*	*Comparison*	*Comparison*	*Group 1 – (Group 2 & Group 3)*	*Group 2 – Group 3*
Girls < 13 years, and all boys	0.841	0.731	0.767	0.095*** (0.031)	-0.037 (0.036)
Girls ≥ 13 years	0.864	0.803	0.811	0.057** (0.029)	-0.008 (0.034)
Preschool, Grade 1, Grade 2 in early 1998	0.795	0.688	0.703	0.100*** (0.037)	-0.018 (0.043)
Grade 3, Grade 4, Grade 5 in early 1998	0.880	0.789	0.831	0.070*** (0.024)	-0.043 (0.029)
Grade 6, Grade 7, Grade 8 in early 1998	0.934	0.858	0.892	0.059*** (0.021)	-0.034 (0.026)
Recorded as "dropped out" in early 1998	0.064	0.050	0.030	0.022 (0.018)	0.020 (0.017)
Females[56]	0.855	0.771	0.789	0.076*** (0.027)	-0.018 (0.032)
Males	0.844	0.736	0.780	0.088*** (0.031)	-0.044 (0.037)

Why would younger students face greater changes in school participation?

Figure 2: School participation rate May 1998 to November 1999 for girls under 13 years old and for all boys, difference between Group 1 and Group 3 (diamonds), and difference between Group 2 and Group 3 (squares)

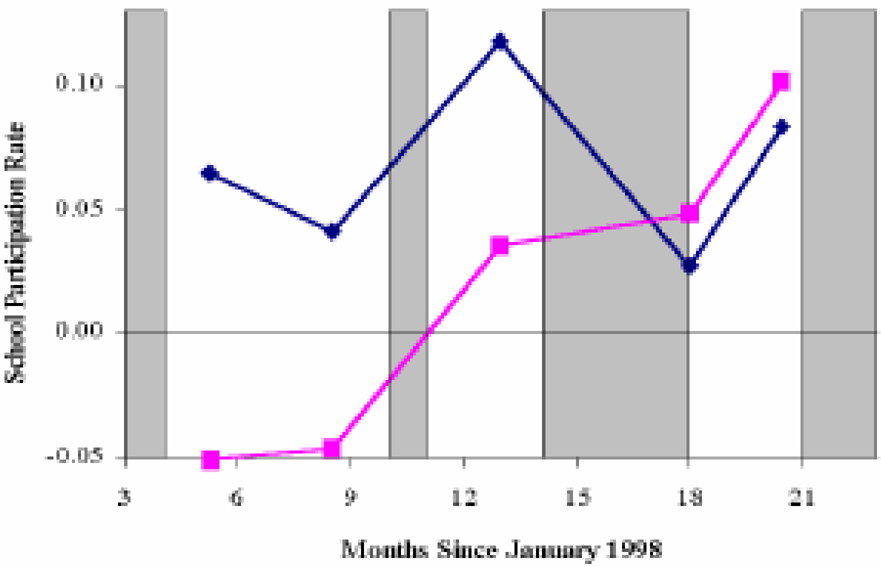
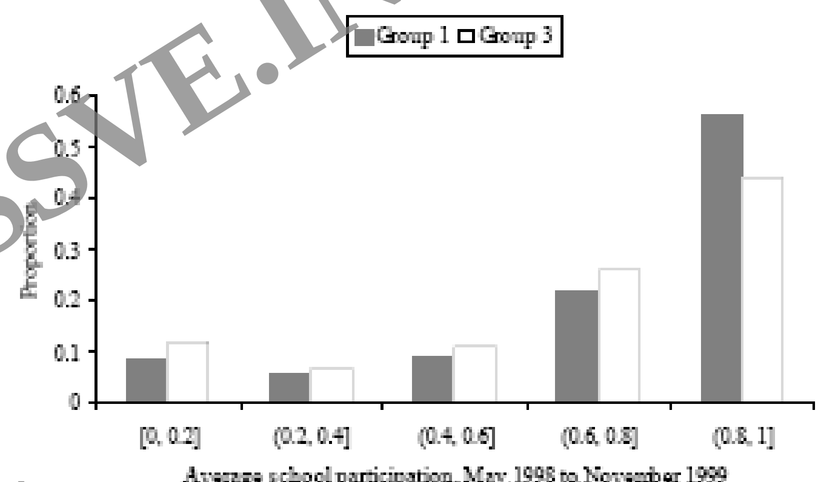


Figure 3: Average school participation rate from May 1998 to November 1999 among girls less than 13 years old and all boys, histograms for Treatment (Group 1) schools and Comparison (Group 3) schools



Implications

Should we implement a deworming treatment policy in Kenya? Is it cost effective?

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Deep Impact: an investigation of the use of ICT for teacher education in the global south

Study Authors: by Jenny Leach with Atef Ahmed, Shumi Makalima and Tom Power

Presented by: Rashmi Melgiri

Problem: More and more African children in need of education from fewer and fewer qualified teachers.

The children

- Over 40M children of primary school age have not yet attended
- Of those who do attend, a small fraction achieve basic skill
- Exploding population growth in this age group

The teachers

- Thousands are under qualified to teach
- Spread of HIV/AIDS taken toll on population of teachers

Curiosity: Can ICT help?

- Rapidly growing mobile penetration (2.8% of African population, but growth rate of 65%)
- Drops in cost of equipment
- Decreasing cost of access

"… it now seems urgent to develop a well-founded experience of the way in which teacher education can benefit from these completely new forms of communication."

Research Aim: 3 questions

1. What is the impact of ICT use on the pedagogic **knowledge and practice of teachers** and the communities in which they live and work?
2. What is the impact of ICT-enhanced teaching on **student achievement and motivation**?
3. How can **teacher education** and training be developed to ensure teacher capacity to **exploit the potential for ICT?**

The approach: case studies

- When: March 2001-May 2003
- Where: 2 cities
  - Cario, Egypt
  - East Cape Province, South Africa
- Who: teachers led by research staff
  - 48 primary school teachers (working in pairs) across 24 schools (12/location)
  - DEEP partner organizations leading a development program for the teachers

Methodology: teacher and school selection criteria

- Radio announcement publicized upcoming study and requested expressions of interest
- 91 schools applied
- Final selection heterogeneous wrt ICT adoption
  - 33% without electricity
  - 50% of schools without telephony
  - 75% without any form of ICT
- Teachers interested and committed to developing their skills

Forms of ICT employed

- Laptops
- Desktops
- Hand-helds
- LCD panel
- Data projector
- Digital cameras and video recorders
- Printer-scanner-copiers
- Mobile phones

Program: 3 terms, teacher + student

- Term 1: Introducing DEEP, the project and ICT
- Term 2: In-school planning and practice
  - Research skills via internet and CD rom
  - Personal communication via email
  - Strengthen numeracy with real data
- Term 3: Organizing learning and Review
  - Drafting and redrafting via word
  - Planning the writing process
  - Reflection on achievement

Key Findings: Qualitative and unqualified

1. **Teacher Confidence:** Teachers quickly developed basic computer and software skills
2. **Extending Teacher Subject Knowledge:** Teachers began to use ICT to learn more about their subject areas
3. **Enhanced planning and preparation:** Teachers using ICT to plan lessons
4. **Building Teacher Networks:** Communication applications led to teachers connecting and collaborating

Little/No discussion of financial sustainability

Stepping back: Prioritization of funds

Excerpt describing one of the sample schools:

The village is reached by an **hour's difficult drive** from the main N2 via an **unmade road**, offering remarkable views … virtually inaccessible in the rainy season. Few adults between the age of 20 and 50 reside there: **many have died from AIDS**, and surviving able-bodied **adults live in towns or cities** most of the year round in order to make a living. On average students live within a **2-mile radius of the school**, mostly with grandparents or other relatives. Fees are between R10 and R30 (£1–3) per annum, depending on the level of study; **90% of students are unable to make this payment**. Classrooms are mostly bare, concrete-floored constructions with dilapidated wooden desks; the youngest **learners are taught in dark**, crowded, thatched rondeavaals.

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The Transformational Potential of M-Transactions

Vodafone
Nokia
Nokia Siemens Networks

Anonymous MIT student

Nov 19, 2008

Vodafone, Nokia, and Nokia-Siemens Networks. *The Transformational Potential of M-Transactions.* Policy Paper Series No. 6 (July 2007).
http://www.vodafone.com/etc/medialib/public_policy_series.Par.89230.File.dat/public_policy_series_6.pdf

Contents

- 7 papers
  - Overview
  - Early lessons from the deployment of M-PESA, Vodafone's own mobile transactions service
  - Trust and Fidelity: from 'under the mattress' to the mobile phone
  - The regulatory implications of Mobile and Financial Services Convergence
  - Airtime Transfer Services in Egypt
  - Competition Issues in the Development of M-Transaction schemes
  - Mobile Transactions: Through the Window of the Two-Sided-Platforms Approach

Overview

- Aim of this report
  - Contribute to the debate among policy makers assessing the potential for mobile transactions
- Present situation
  - Lack of access to financial service
  - Bad service condition
  - Growth of microfinance
  - Importance of remittance
- Key issues
  - Unknown needs
  - Cultural issues
  - Network effects
  - Regulations

Lack of access to financial service

Image removed due to copyright restrictions.
See Overview: Figure 1, “Number of bank branches and ATMs per 100 people...” in *The Transformational Potential of M-Transactions.*

High interest rate on loans

Image removed due to copyright restrictions.
See Overview: Figure 2, "Interest rates on loans..."
in *The Transformational Potential of M-Transactions.*

Growth of microfinance

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See Overview: Figure 3, “Microfinance clients as % of population…” in *The Transformational Potential of M-Transactions.*

Importance of remittances

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See Overview: Figure 4, "Financial flows to developing countries, 1990-2006" in *The Transformational Potential of M-Transactions.*

Overview

- Aim of this report
  - assessing the potential for mobile transactions
- Present situation
  - Lack of access to financial service
  - Bad service condition
  - Growth of microfinance
  - Importance of remittance
- Key issues
  - Unknown needs
  - Cultural issues
  - Network effects
  - Regulations

Early lessons from the deployment of M-PESA

- M-PESA
  - Mobile-based payment service in Kenya
  - Launched in 2007 by Vodafone and Safaricom
  - Targeting un-banked pre-pay mobile subscribers
- Service
  - Deposit and withdraw at Safaricom's agents
  - Mobile transaction with Airtime

Early lessons from the deployment of M-PESA

Image removed due to copyright restrictions.
See M-PESA: Figure 1, "Access to Formal Banking" in *The Transformational Potential of M-Transactions.*

Early lessons from the deployment of M-PESA

- New usage characteristic
  - Paying remote staff their expenses
  - Deposit before boarding a bus
- Registration
  - 111,000 users in the first 3 months.
  - 3.6 million* users by July 2008

*http://wirelessfederation.com/news/category/m-pesa/

Trust and Fidelity: from 'under the mattress' to the mobile phone

- WIZZIT in South Africa

Image removed due to copyright restrictions.
See Trust and Fidelity: Figure 2, "Wizzit's mobile banking system" in *The Transformational Potential of M-Transactions.*

Trust and Fidelity: from 'under the mattress' to the mobile phone

- M-PESA in Kenya

Image removed due to copyright restrictions.
See Trust and Fidelity: Figure 3, "The M-PESA System"
in *The Transformational Potential of M-Transactions.*

Trust and Fidelity: from ‘under the mattress’ to the mobile phone

- Globe Telecom (G-cash) in Philippines

Image removed due to copyright restrictions.
See Trust and Fidelity: Figure 5, “Money transfer...”
in *The Transformational Potential of M-Transactions.*

Trust and Fidelity: from 'under the mattress' to the mobile phone

Image removed due to copyright restrictions.
See Trust and Fidelity: Summary table – function and characteristics in *The Transformational Potential of M-Transactions.*

Trust and Fidelity: from 'under the mattress' to the mobile phone

Image removed due to copyright restrictions.
See Trust and Fidelity: Summary table – consumer experience in *The Transformational Potential of M-Transactions.*

Trust and Fidelity: from 'under the mattress' to the mobile phone

- Potential of mobile payment
  - Reducing information asymmetries
  - Quality of life impact
- Hurdles
  - Widespread cash-in, cash-out system
  - Regulatory compliance
  - Tariff structures for consumers

The regulatory implications of Mobile and Financial Services Convergence

- Deposit Taking
  - Lower barriers to deposit taking
  - Carefully select the asset classes in which transaction banks can place depositors' funds
  - Ensure new entrants have access to central payment infrastructure
- Cross Border Remittances
  - Create international regulatory structures that facilitate cross-border services
  - Facilitate the development of economies of scale across borders
  - Facilitate innovation via the remittance markets

The regulatory implications of Mobile and Financial Services Convergence

- Distribution Channels
  - Revise outsourcing rules
  - Adjust customer due diligence guidelines
  - Consumer Protection
  - Consider scope for telecoms regulators to act
  - Devise appropriate consumer protection measures
- Regulatory Processes and Reviews
  - Set review clauses on regulatory reforms, evaluate and adjust
  - Allow for up-market and cross market expansion

Airtime transfer service in Egypt

- BTS
  - Balance transfer service in Egypt
  - Launched in 2004 by Vodafone
  - Around 1.7 million customers make 20 million transactions every month*

*http://www.vodafone.com/start/responsibility/our_social___economic/access_to_communications/m-transactions.html

Airtime transfer service in Egypt

- Findings from survey on BTS
  - – BTS increases access to mobile services
  - – BTS improves affordability
  - – BTS creates commercial opportunities
  - – BTS use supports social networks through
  - – BTS is not used as a proxy currency due to

Competition Issues in the Development of M-Transactions Systems

- Competition w/o interconnectivity
  - Monopolized by the leading operator soon, due to strong network effect
  - No choice for customers
  - Service level decreases

- Should regulators intervene to secure interconnectivity?

Competition Issues in the Development of M-Transactions Systems

- Benefit side of intervention
  - Increase network benefit
  - Low switching cost for customers
  - Rapid market growth
  - Long-run competition
- Cost side of intervention
  - Less competition in nascent market
  - Low incentive to innovation

Competition Issues in the Development of M-Transactions Systems

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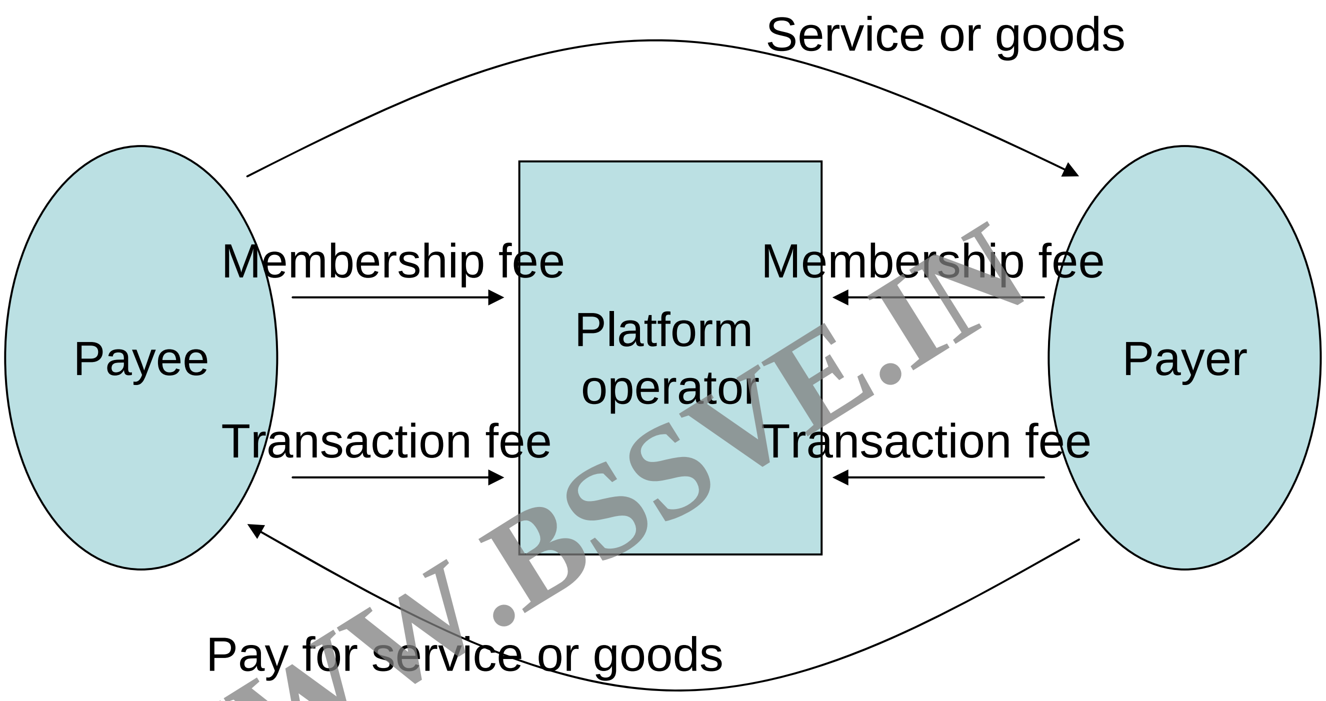
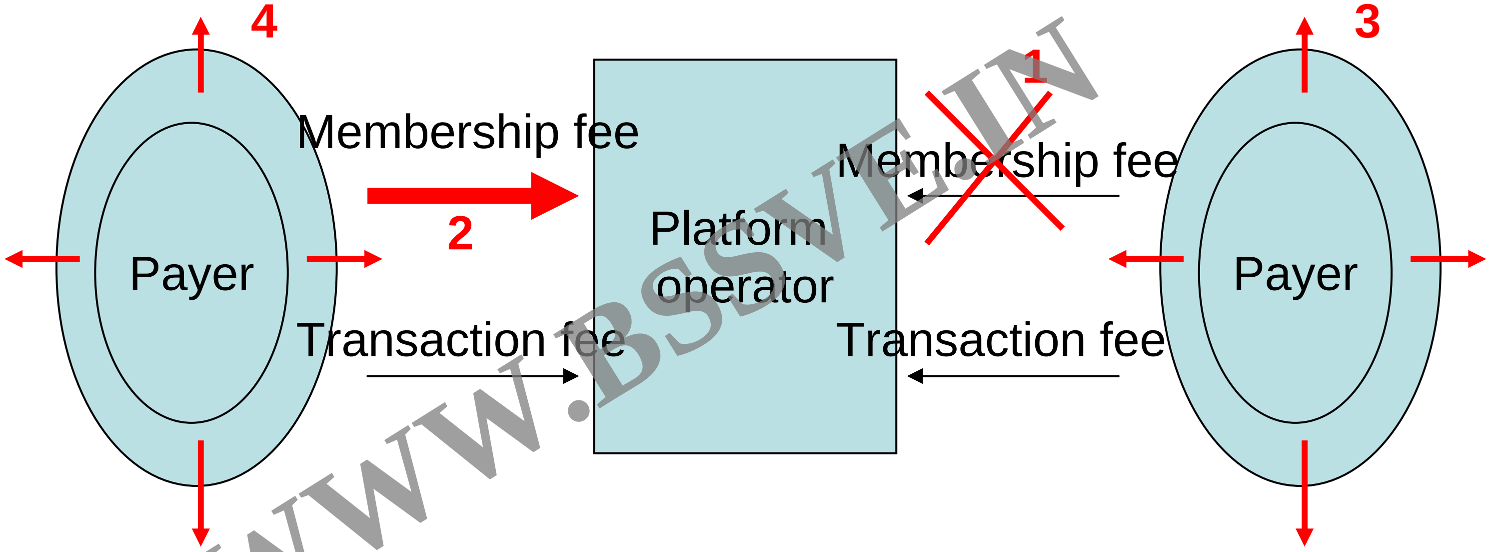
Mobile Transactions: Through the Window of the Two-Sided-Platforms Approach

- Two-sided-platform



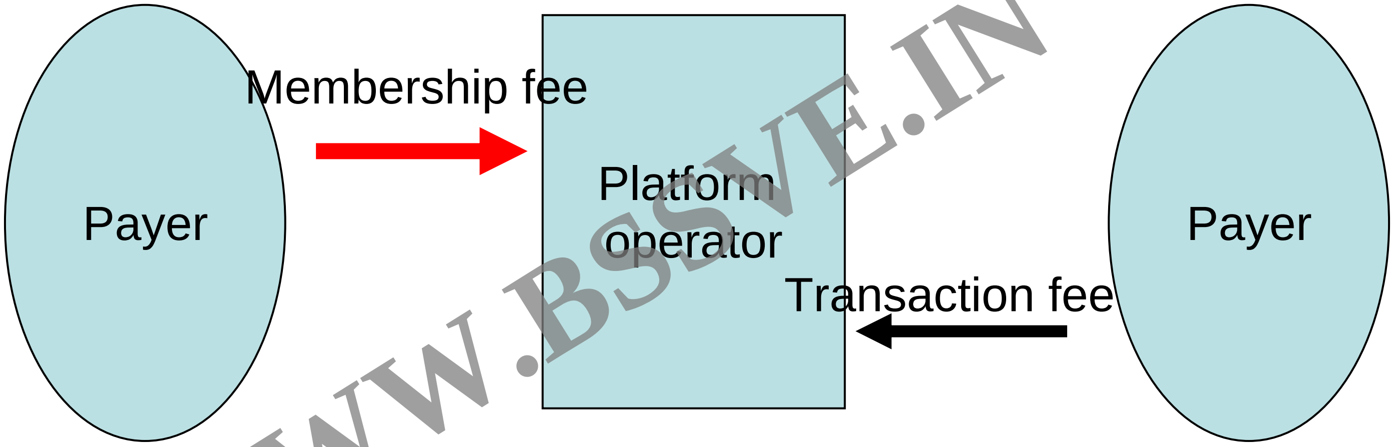
Mobile Transactions: Through the Window of the Two-Sided-Platforms Approach

- Membership fee
  - Divide-and-conquer strategies
  - Tying strategies



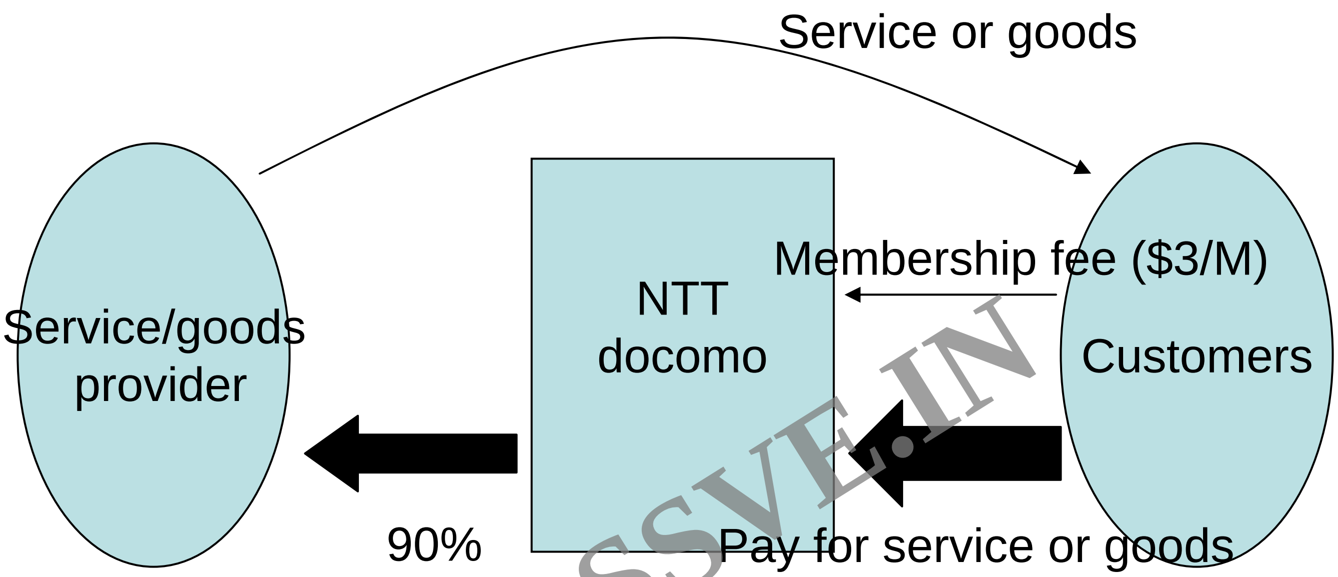
Mobile Transactions: Through the Window of the Two-Sided-Platforms Approach

- Transaction fee
  - Step1: Determine total transaction price
  - Step2: Determine allocation on both sides



Discussion

- NTT docomo i-mode platform



Pay together with communication charges

MIT OpenCourseWare
http://ocw.mit.edu

MAS.965 / 6.976 / SP.716 NextLab I: Designing Mobile Technologies for the Next Billion Users
Fall 2008

Micro-Payment Systems in Mobile Networks
A Report by infoDev, IFC, and GSMA

By anonymous MIT student

November 19, 2008

Why m-Commerce?

- Gap in banking system access between developed and developing nations
- Cash-dependent society is not ideal
- Pre-paid mobile services
- Demonstrated ability to perform simple financial transactions and SMS usage

The Philippines Experience

- Reliance on cash for day-to-day subsistence
- 'Sachet' purchasing
- Prepaid segment → low margin, high volume
- Reduced minimum from $6 to $0.6
- Can we go even lower?

SMART Money and G-Cash

- Cash deposits/withdrawals
- Transfer of cash to airtime
- P2P transfer of airtime or cash
- International remittances
- Cashless retail purchasing
- Bill payment
- Payroll
- …

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- …

$0.04!!

SMART Money and G-Cash

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- **International remittances**
- **Cashless retail purchasing**
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- Payroll
- …

> $50 million/ month

SMART Money and G-Cash

- Cash deposits/withdrawals
- Transfer of cash to airtime
- **P2P transfer of airtime or cash**
- **International remittances**
- **Cashless retail purchasing**
- Bill payment
- Payroll
- …

SMART Money and G-Cash

- Interface
  - SMS or menu-based SIM (GSM only)
- Service Charges
  - SMS text for transactions ($0.02)
  - 1% fee on cash transfers (with minimum)
  - SMART Money-specific
    - Annual Charge of $4 for debit card
    - ATM charges for debit card use

SMART Money vs. G-Cash

- 2000 vs 2004 (2.5 vs 1 million users)
- SMART Money offers MasterCard debit card
- G-Cash launched 4 years after SMART Money, but offers more:
  - Payment of taxes and annual fees
  - Online payments for movies, games, etc.
  - Micro-finance (with ‘rural banks’)
- Different implementations

The Two Models

- ‘Access Model’

Image removed due to copyright restrictions. See Figures 1 and 4 in
Wishart, Neville. 2006. *Micropayment Systems and Their Application to Mobile Networks*.
infoDev / World Bank. Available at: http://www.infodev.org/en/Publication.43.html

The Two Models

- ‘Hybrid model’

Image removed due to copyright restrictions. See Figure 2 in
Wishart, Neville. 2006. *Micropayment Systems and Their Application to Mobile Networks*.
infoDev / World Bank. Available at: http://www.infodev.org/en/Publication.43.html

Benefits – Providers

- For service provider
  - Higher profits (ARPU, cards)
  - Higher penetration (low-income markets)
  - Less ‘churn’, more loyalty (from 3% to 0.5)
- For bank (provider in ‘hybrid model’)
  - Higher profits (more transactions)
  - Increased outreach

Benefits – Clients

- For the end user
  - Convenience
  - Safety at low cost
  - Time saving
- For third parties
  - Easy micro-loan issuance and repayment
  - Retailers earn 15% commission
  - Time-value of cash
  - No need for remote locations

Other Considerations

- Bad debt provision
- Regulation → Imposes limits
- Network Traffic and security
- Regardless of model, need transaction processing engine
  - Really?
- Revenue and cost
  - Increased ARPU (by time-limiting airtime)

Further discussion

- Debit Cards – good or bad?

- High relative fee
- Use of ATMs
- Purchases aren't limited to selected retailers

Further discussion

- ‘Access model’ vs. ‘Hybrid model’

- Regulation
- Profit (e.g. $10 million)
- Investment in banking system
- Flexibility

Further discussion

- What other services can be enabled?

- Incorporate with retailer's POS so they don't *need* an account as well
- Micro-finance

Further discussion

- Why hasn’t this happened here?

- Familiarity with SMS
- Big segment of population ‘unbanked’
- Regulatory concerns

Further discussion

- How about in other developing countries?

- Airtime transfers already exist
- Lack of infrastructure?
- Happening in many places → Ideal to have a common interface

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Fall 2008

BMC Medical Informatics and Decision Making

BioMed Central

Research article

A web-based laboratory information system to improve quality of care of tuberculosis patients in Peru: functional requirements, implementation and usage statistics

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Abstract

Background: Multi-drug resistant tuberculosis patients in resource-poor settings experience large delays in starting appropriate treatment and may not be monitored appropriately due to an overburdened laboratory system, delays in communication of results, and missing or error-prone laboratory data. The objective of this paper is to describe an electronic laboratory information system implemented to alleviate these problems and its expanding use by the Peruvian public sector, as well as examine the broader issues of implementing such systems in resource-poor settings.

Methods: A web-based laboratory information system "e-Chasqui" has been designed and implemented in Peru to improve the timeliness and quality of laboratory data. It was deployed in the national TB laboratory, two regional laboratories and twelve pilot health centres. Using needs assessment and workflow analysis tools, e-Chasqui was designed to provide for improved patient care, increased quality control, and more efficient laboratory monitoring and reporting.

Results: Since its full implementation in March 2006, 29,944 smear microscopy, 31,797 culture and 7,675 drug susceptibility test results have been entered. Over 99% of these results have been viewed online by the health centres. High user satisfaction and heavy use have led to the expansion of e-Chasqui to additional institutions. In total, e-Chasqui will serve a network of institutions providing medical care for over 3.1 million people. The cost to maintain this system is approximately US$0.53 per sample or 1% of the National Peruvian TB program's 2006 budget.

Conclusion: Electronic laboratory information systems have a large potential to improve patient care and public health monitoring in resource-poor settings. Some of the challenges faced in these settings, such as lack of trained personnel, limited transportation, and large coverage areas, are obstacles that a well-designed system can overcome. e-Chasqui has the potential to provide a national TB laboratory network in Peru. Furthermore, the core functionality of e-Chasqui as been implemented in the open source medical record system OpenMRS http://www.openmrs.org for other countries to use.

Background

Tuberculosis (TB) is a chronic infectious disease that kills over 2 million people per year in the developing world. TB can typically be diagnosed rapidly by sputum microscopy at a local health facility, but diagnosis of multi-drug resistant TB (MDR-TB) – defined as TB strains resistant to at least isoniazid and rifampin – requires a drug susceptibility test (DST) which is usually performed at a regional, national or even supranational level. The emergence of extensively drug-resistant tuberculosis (XDR-TB) heightens the urgency of prompt diagnosis of drug resistance to curb the excessive mortality and ongoing transmission associated with highly resistant strains [1]. Communication of DST results between central and local laboratories and clinical facilities can be problematic and results can take several months [2] to get to their destination or never arrive [3], especially in high-burden countries with limited infrastructure. Prompt treatment with individualized drug regimens based on DST improves patient outcomes [4] and reduces the risk of amplification of drug resistance and ongoing transmission [5,6]. As Raviglione and Smith comment in a recent editorial, "information is essential to build a response [to drug-resistant diseases], and only computerized information systems allow sufficiently rapid exchange of information within and between countries[7]."

Laboratory Information Systems

Laboratory information systems in developed countries have been shown to decrease turn-around-times (TAT) of laboratory results [8-10], reduce redundancy in resource utilization [9,11,12], and provide faster and more complete notification for public health purposes [13-15]. Shorter TATs have been associated with decreased treatment time, mortality, morbidity, and length of hospital stay [16,17]. We are aware of the use of laboratory systems in the central laboratories in a few developing countries such as Peru and Russia. However, to our knowledge, there are no reports of the use of these systems to link laboratories to clinical settings.

There are potentially greater benefits of using clinical information systems in locations with limited infrastructure where other methods of communications are more costly. However, though they can provide many benefits, these systems are difficult to implement. In developed countries, it is estimated that up to 60% of all information technology implementations in health care fail [18]. Among the many challenges that need to be surpassed are over-burdened laboratory and clinical personnel, frequent staff rotation, limited computer and internet access, and frequent changes in administrations and policies.

Creating a Peruvian National Laboratory Network

The implementation of decentralized, rapid DST is underway as part of nationwide efforts to scale up services for detection and treatment of MDR-TB and XDR-TB by the Peruvian Ministry of Health [19]. Whereas initially only the Peruvian National Reference Laboratory (NRL) performed DST, the capacity of the regional laboratories has expanded to include rapid and conventional first-line DSTs. The typical flow of a suspected TB patient's sputum sample from the initial treatment site through the laboratory network is depicted in Figure 1. Each test result is communicated serially, and in each step, there are delays and the potential to lose the result.

A study of TATs for cultures and DSTs within the Peruvian public health system suggests that patients could still experience risky delays despite availability of decentralized, rapid DST unless programmatic aspects are also addressed [2]. In addition to reducing communication delays, minimizing lost and erroneous results is essential for reducing morbidity in these high-risk patients. To improve these aspects, we developed and implemented the laboratory information system described herein.

This paper describes the design and implementation of a web based TB laboratory information system to communicate data between a national laboratory, two regional laboratories, and 12 health centres (HC) in Lima, Peru. This system was designed to support a national TB laboratory network connecting all participating institutions. We then describe the expansion of the system at the request of the public administration. Finally, we examine broader issues of implementing these types of systems in resource-poor settings including costs and sustainability.

Methods

Needs Assessment

The first step in creating the laboratory information system was to conduct a needs assessment of the major stakeholders: the personnel in the HCs, regional, and national laboratories. After working with the director, laboratory technician and data entry staff in the participating laboratories and the TB clinician, nurse and local laboratory technician in several key HCs, a list of information requirements was created, shown in Table 1. While most requirements were identified during this initial period, others emerged during the implementation process.

Integration into Laboratory Workflow

The laboratory information system needed to be integrated within the workflow of the busy regional and central laboratories. We performed a thorough workflow analysis of each laboratory's systems of information, each staff's responsibilities, quality control, and tests performed, and designed the system to follow the current

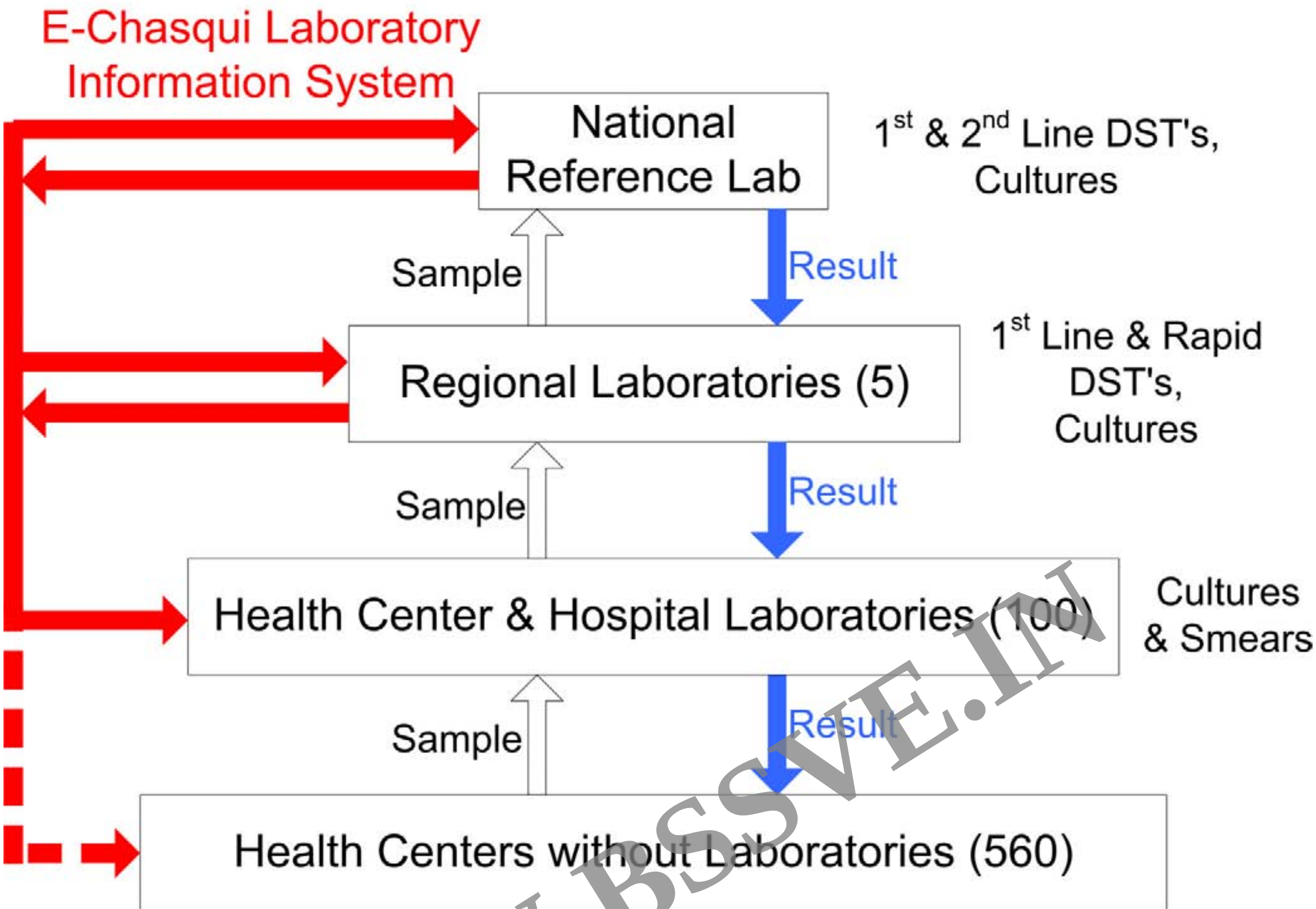

Figure 1
Tuberculosis Laboratory Structure/Workflow in Lima and Locations of e-Chasqui Implementation.

workflow of intake, processing, and reporting. However, the integration of the information system still required workflow adjustments to incorporate data entry, digital verification, and printing of results from the system. This was done through iterative discussions with the laboratory directors followed by an hour-long training session for all laboratory personnel. These changes in workflow, however, did not result in increased time demands; instead the revised system resulted in greater efficiency for most laboratory personnel, since the database (with reliable back-up) obviated the need to photocopy and maintain physical copies of all results at the laboratory.

Finally, the laboratory information system had to integrate with current laboratory reporting systems being used. During the implementation of e-Chasqui the NRL moved from using the PHLIS laboratory reporting system [20], to an in-house developed laboratory management system. To communicate data between these systems, a tool was created to manually export all results; we are currently defining other inter-system communication methods.

System Design
The electronic laboratory information system, called e-Chasqui, supports the decentralized entry and viewing of bacteriological tests (smear microscopy, cultures, species identification, and DSTs). The Chasquis were agile and highly-trained runners that delivered messages, royal delicacies and other objects throughout the Inca Empire and are a source of pride in Peru. In addition, it includes applications to assess quality control, generate aggregate reports, notify health centres of new results or contaminated samples, and track both enrolled patients and the status of pending laboratory tests. e-Chasqui extends the web-based TB electronic medical record system, PIH-EMR, that has been in use in Peru since 2001 [21,22]. To protect patient's confidentiality, e-Chasqui incorporated

Table 1: Needs Assessment of Health Centres and Laboratories

Health Centres
All information displayed to mirror paper forms
Find patient by name despite constant misspellings
Fast access despite low bandwidth
Easily access patient's individual result and history of all results
For a sample view all tests performed and date when sample was taken
View all recent results by HC
Track all tests pending by HC
Access information on samples collected in other institutions (e.g. while hospitalized, prior to transfer to their HC)
Email notification of new test results
Print out a test result in the official MINSA format
Display trend in DST requests by HC
Show MDR-TB patients not appropriate treatment
Current patients failing treatment
Access latest information on evidence-based TB treatment
Laboratories
Integrate into laboratory workflow with minimal disturbance or increased work
Search for sample by ID number
Individual results printed in current paper form
Aggregate reporting for all tests entered
Ability to view all culture and DST results reported within an arbitrary time period
Improve quality control of test results
Ability to modify or "grow" system with continual requirements
Compatibility with existing computerized information systems

extensive encryption and web security features for medical records of the PIH-EMR [23]. Furthermore, all users sign a confidentiality agreement before being given access.

We worked with the national and regional district and laboratory directors to define the access profiles for the different types of users. Clinical personnel have individual access to all patients under their responsibility e.g. single HC, multiple HCs, or a full district. Examples of clinical personnel include HC staff, the regional TB program director, and the regional treatment approval committees, composed of pulmonologists and clinicians. Laboratory personnel have both an individual and aggregate view of laboratory test results. Defining the types of access, getting all stakeholders to agree, and building the flexibility into the system was one of the most difficult tasks in building e-Chasqui.

The ultimate goal of the system is for all laboratories, including those at HCs, to enter tests they've performed and use the system to order further tests. However, in the initial phase all data was entered at the NRL and regional laboratories with "read-only" access provided to HCs. Therefore when the first e-Chasqui laboratory receives a sample, they enter all previous test results performed on that sample.

Patient Care

The core of the e-Chasqui interface is a single patient page containing the history of all tests performed for the patient on a left sidebar, and the details for any single sample on the main part of the page (Figure 2). For a single sample, tests can be performed by up to four different laboratories. All test results are displayed in this single page to give the full history of the sample. This novel tracking ability is a useful addition; prior to e-Chasqui's implementation, laboratory and clinical personnel systems lacked the test request date or the smear or culture data when they received a DST result. The system uses a flexible search algorithm by either the patient's names (including partial names) or by any of the sample's test identification numbers. This patient page, like all others, contains only text and uses optimized SQL queries to load quickly even in areas with low bandwidth.

From this page, the user can select which tests to print in the official report format. Though each HC can print the report immediately after laboratory verification, each laboratory also prints a copy and sends this stamped "official" report to the HC for their paper records. Due to the high load of TB patients, the HC personnel requested the ability to view their latest results on a single page and track the status of all their samples being processed. Tools were designed to meet these requirements. Finally, all HC users receive nightly email notifications for new test results on patients attending their HC.

Laboratory Quality Control

The laboratory personnel described long-standing problems with ensuring the timeliness of reporting results. Since a culture or DST result takes 20 to 60 days to be read, some tests "fell through the cracks" and were not read, or

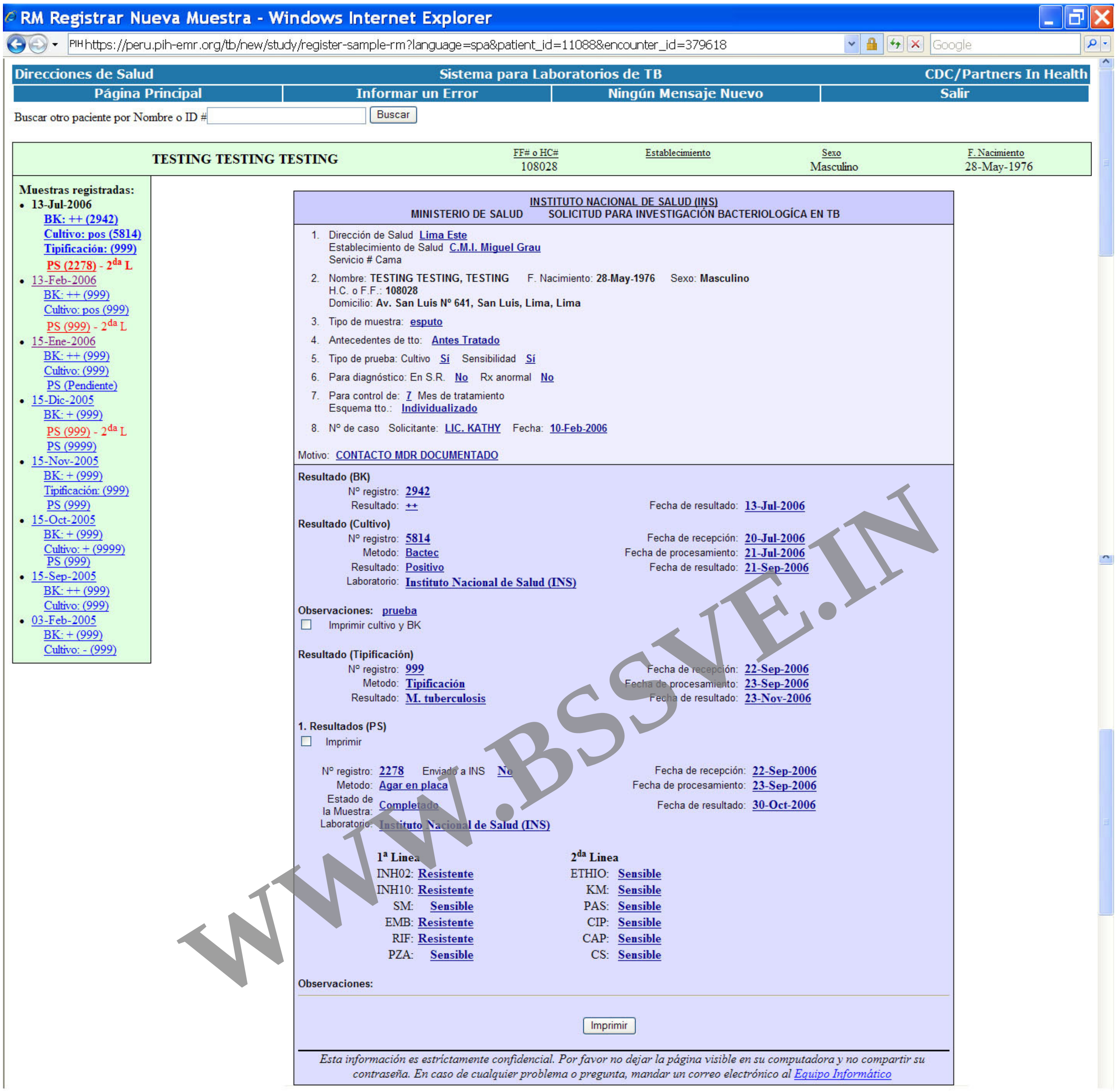

Figure 2

e-Chasqui main patient page. This page shows the patient's full bacteriological history on the left sidebar and with bolded sample date for the sample whose results were being displayed on main part of page.

were read late. Furthermore, they also requested ways to ensure all results had been entered, to minimize duplicate tests, and to monitor the contamination rate. Therefore, the system was expanded to incorporate quality control tools to remind personnel to read samples on a regular basis, flag duplicate or missing results, and report contamination rates. These tools are usually automatically updating tables or lists of tests that show the appropriate information.

Laboratory Monitoring/Reporting

An initial reporting tool was created for the regional laboratories to view all results. Further monitoring and reporting tools were created as the needs arose throughout the implementation process. They can be seen in Table 2.

Table 2: Reports generated by e-Chasqui

Report	Informed	Purpose	Type of Access
Frequency of e-Chasqui access by HC personnel	Regional laboratory and TB director	Encourage frequent utilization of IS to access real-time laboratory data	Monthly report prepared by data administrator
Number of laboratory results entered at regional laboratory	Regional laboratory and TB director	Identify delays in data entry	Monthly report prepared by data administrator
Number of laboratory results verified and released to providers	Regional laboratory and TB director	Identify delays in verification	Monthly report prepared by data administrator
DST results for any specified period grouped by every variable in request form	Regional and INS laboratory director	Report and identify trends in laboratory performance	Constant access**
Culture results for any specified period grouped by every variable in request form	Regional and INS laboratory director	Report and identify trends in laboratory performance	Constant access**
Individuals with a positive culture for any specified date	Regional and INS laboratory director	Report to regional TB program	Constant access**

**Constant access means that the laboratory users could view this information in the system at any time. Some reports let the user specify the start and end dates.

Implementation

Though described separately from the needs assessment and system design, the deployment of e-Chasqui in the laboratories and HCs was complementary and overlapped as the use and functionality of e-Chasqui grew.

Information Technology Assessment

The initial step of implementation consisted of an assessment of the information technology status at each HC and laboratory, performed by the regional health districts, and included data such as the number and condition of computers in each HC, physical security, and internet access. The assessment identified key deficits, and we were able to coordinate with each health district to perform corrections such as donating or fixing computers and providing or improving internet access.

Laboratories

The commitment of the health districts was demonstrated by providing a part-time data entry person specifically for e-Chasqui. We trained all laboratory staff in the workflow changes and in the use of e-Chasqui during a single 1-hour group training session. We also had individualized sessions for each user since each had different responsibilities, on average lasting approximately 1.5 hours. After several months of use, two of the three laboratories requested that the technicians also have e-Chasqui access.

For data entry several simple design tools were implemented and found to be valuable. First, for ease of data entry each data field can be accessed not only by clicking on the field with the mouse, but also by sequential tabbing through the page. Second, the main patient page was identical to the test request form from which the data entry occurred. To avoid duplicate patients when a new patient is being created, e-Chasqui searches for patients with similar names, and if any are found a warning is displayed where the user can click on one of the existing patient names or click the "Create New Patient" button. Also, a tool to merge patient records was created to handle duplicates. Duplicate sample records are handled using data quality tools, explained previously in the Laboratory Quality Control section

The system had to be continually expanded and adapted to the needs encountered during the pilot phase. During the first eight months after implementation, functionality to generate lists of reported DSTs and the quality control tools were created. In the following 3 months, we added pages for the HC users to view the tests currently being processed and a consolidated view of the last 3 weeks of results. In Sept. 2006, 11 months after initial implementation, the NRL began to use this system required changes to accommodate its specific workflow. At the same time we modified the system, at HC users' request, to send only one email at night if results had been verified that day, as opposed to an email for every result verified.

Health Centres

Once a HC had a computer with internet access that could be used by the TB personnel, all users were trained in a single 1-hour session in computer use, confidentiality procedures, and use of e-Chasqui. The e-Chasqui data administrator then performed follow-ups every third week. In most HCs, we identified at least one "champion" who uses the system frequently. However, rarely did we find this champion promoting the system to others.

Throughout the implementation, we had to troubleshoot problems. Most of the problems were administrative or hardware related such as having to create a new windows XP user, ensuring that HC users were viewing their results in e-Chasqui in a timely fashion, replacing a stolen computer, and providing six web access points to TB programs within HCs that lacked computer access (Baobab Health Partnership) [24].

Results

The needs assessment and workflow analysis began in June 2005, with the first user testing in July 2005, January 2006, and May 2006, for each of the two regional and the national laboratories, respectively. Full implementation occurred in March 2006, August 2006, and September 2006, respectively.

System Usage

Our system has been successfully integrated into program operations. Since its initial implementation, 29,994 smear microscopy, 31,797 culture and 7,675 DST results have been entered. In 2006, 99.5% of all DST results and 98.8% of all culture results for the 12 pilot HCs were viewed online. The average number of pages viewed by the HCs in each of the two health districts (Lima Ciudad, Lima Este) can be seen in Figure 3. The large increase in pages viewed in August 2006 occurred because e-Chasqui was fully implemented in both the Lima Este regional laboratory and the NRL.

This is an online transaction processing system and since it is used in sites with low to medium internet bandwidth, this is a major factor in its performance. Due to e-Chasqui's simple, text-based design all sites can use it during routine clinical and laboratory work. In 2006, the system performed on average 1865 transactions per day including page views, data entry, and analysis. In 2007, it has increased to 4501 daily transaction and the system's performance has not been appreciably affected. Feedback from users has been positive. This feedback has been in the form of conversations by the research staff with the clinical and laboratory personnel, increased usage of the system by intervention sites, and requests for expansion of the use of the system by the district and laboratory administrators. Importantly, we have been careful to respond to critical comments and suggestions to enhance the system and maintain user "buy-in." A strong indicator of the system's utility is that district administrators have requested expansion of the system to additional institutions. In response, we are expanding access to three laboratories, 2 hospitals and 11 HCs that administrate 47 other health centres. In total, e-Chasqui will serve a network of institutions providing medical care for over 3.1 million people.

System Costs

In quantifying the costs of designing and implementing this web-based system in Peru, we have found the annual recurring cost to be US$34,738 total or US$0.53 per sample entered. More details can be found in Table 3. This fig-

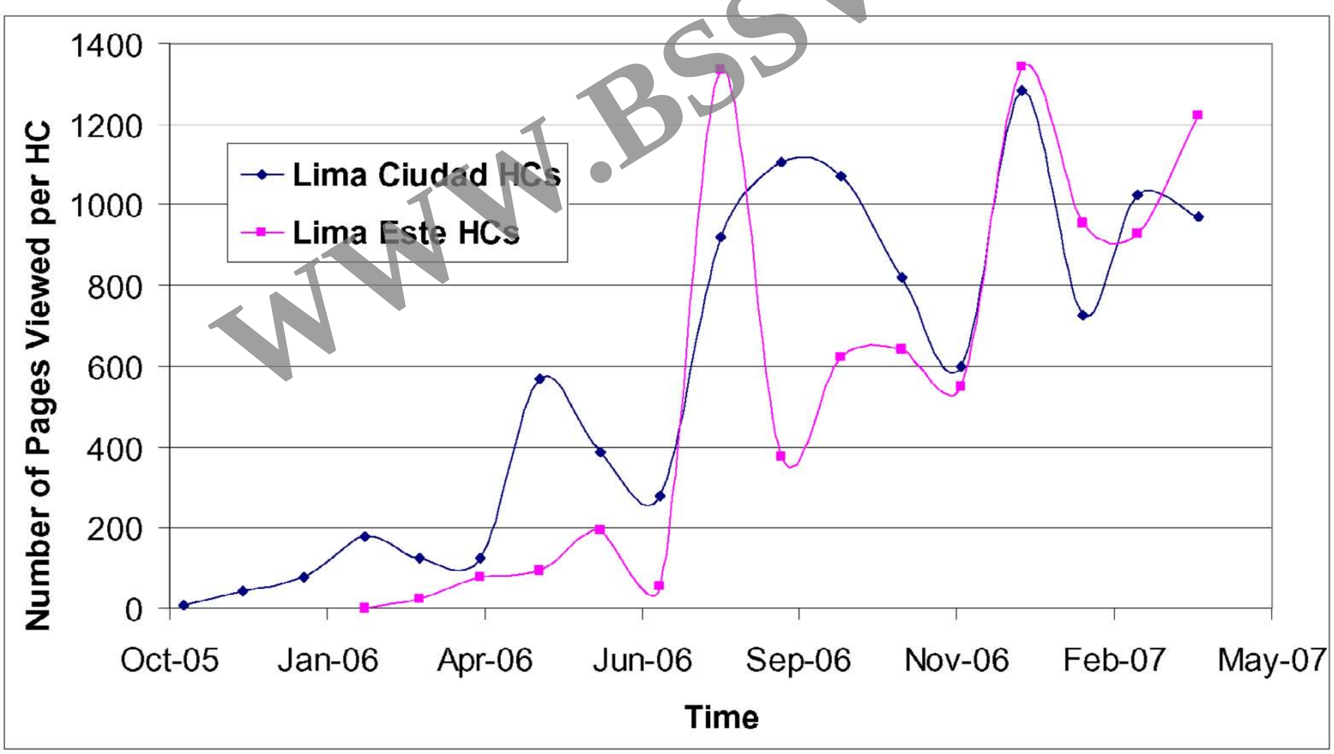

Figure 3

Average monthly number of pages viewed by health centres (HC). The average number of pages viewed by the HCs in each of the two health districts (Lima Ciudad, Lima Este) where e-Chasqui is implemented. Full implementation occurred in March 2006 (Lima Ciudad) and August 2006 (Lima Este).

Table 3: Fixed and Monthly Costs of implementing e-Chasqui

	Calculation	Fixed Cost	Monthly Cost
Infrastructure Building			
Computers, web access points and installation	8 × $458 (average cost)	$3,666.00	
Printers	4 × $150	$600.00	
Server		$2,500.00	
Internet for health centres and labs	12 HCs & 2 labs × $41 monthly		$574.00
Internet for headquarters with server	1 HQ × $400 monthly		$400.00
Total		$6,766.00	$974.00
System Design & Development			
Peruvian Clinician	80 hours × $21/hour	$1,680.00	
System Manager	500 hours × $22/hour	$11,000.00	
Faculty Consulting	40 hours × $59/hour	$2,360.00	
Programmer	100 hours × $40/hour	$4,000.00	
Total		$19,040.00	
System Implementation			
System Manager	620 hours × $22/hour	$13,640.00	
Faculty Consulting	80 hours × $59/hour	$4,720.00	
Programmer	450 hours × $40/hour	$18,000.00	
Total		$36,360.00	
Data Entry & Management			
System Manager	1/4 time		$937.50
Peruvian Data Administrator	2/3 time		$253.33
Peruvian Data Entry (one per lab)	3 × 2/3 time		$580.00
Transportation for Data Administrator	1.5 monthly visits to every site		$150.00
Total			$1,920.83
System Advocacy			
Peruvian Clinician	100 hours × $21/hour	$2,100.00	
Faculty Consulting	50 hours × $59/hour	$2,950.00	
System Manager	200 hours × $22/hour	$4,400.00	
Total		$9,450.00	
Grand Total		**$71,616.00**	**$2,894.83**

We have divided the costs into five categories: infrastructure building, system design and development, system implementation, data entry and management, and system advocacy. For infrastructure, the objective is to have every health institution with a computer, printer and intermittent, if not constant, internet connection. System advocacy has consisted of meetings and discussions, usually with national or regional administrators, to discuss the system's potential benefits, provide updates on its status, and train users on the system's abilities since this was the first time a web-based clinical system had been implemented. The costs incurred by a new program implementing e-Chasqui should be reduced as they will not include system development. All costs are in 2007 U.S. Dollars Unless explicitly stated all staff are US based

ure includes the cost of full internet access to all e-Chasqui institutions and a US based system manager. Since HCs use the internet for other purposes, including the national health register, we feel the system should incur 50% of the internet cost. Also, if the system manager was Peruvian with a local salary, the annual recurring cost reflects the approximate cost of implementing e-Chasqui in all major health centres in the two health districts. For comparison, the e-Chasqui health districts had 1103 MDR-TB patients on standardized or individualized treatment in 2006. The annual cost of these treatments are approximately US$2,900 and US$3,000, respectively [25]. Another comparison is that these health districts accounted for 53% of TB and MDR-TB patients in a national program whose 2006 budget was close to US$10 million [26]. In either case, this system to communicate all vital laboratory data for TB and MDR-TB treatment accounted for approximately 1% of the budget for those districts.

Discussion

Challenges and Obstacles

Creating a system with enough flexibility to meet all stakeholders' needs that arise during implementation

Though e-Chasqui has focused functionality, the need to create many types of users and to define methods of communication between institutions took much work and time. There were two main reasons for this. First, the inexperience in implementing clinical information systems among stakeholders meant much learning about this topic had to take place. As a result, the technical requirements of e-Chasqui were constantly revised. For example, some stakeholders were unfamiliar with the concept that different users see information in specific manner such as individual or aggregate views. Therefore some exhibited initial scepticism about the system's ability to maintain information confidential. Second, defining appropriate user accesses to balance patient confidentiality with users' request for information. Again due to e-Chasqui's novelty, both the developers and the institutions have had to learn what the appropriate user permissions were. Here the web-based architecture allows e-Chasqui to track all users' actions. This capability was highly valued by all stakeholders since many of them asked about data confidentiality and security.

Maintaining both high data quality and timeliness with limited staff

The balance between opportune entry of results and electronic verification with high data quality continues to be a problem. The mean number of days between a DST result being read, its entry, and verification is 5.8. Though we believe that the additional step of result verification ensures higher data quality, we are still working to minimize these delays. On the other hand, the average number of days from laboratory verification to the HC personnel viewing their result in e-Chasqui is 2.2 which shows their interest in updated results.

Strengthening public infrastructure

To ensure e-Chasqui had lasting impact on patient care, it was necessary to integrate this system within the public health structure. Though this can mean additional work in terms of agreements with the different national and regional institutions, as well as providing additional services, the long lasting benefits, such as sustainability and implementation at a national level, usually outweigh this additional work.

Lessons learned

TB programs trying to improve communications, monitoring, and patient care by implementing electronic information systems face a task that can sometimes seem overwhelming. We have learned several lessons from our experience developing a nation-wide electronic laboratory information system in Peru.

All important stakeholders must contribute to the design and implementation

This is the only way to ensure the system addresses the actual user needs and to have user appropriation. To identify key system attributes during the design, medical and laboratory personnel must be involved from the beginning. Furthermore, developers must create a system easily integrated into the existing workflow with minimal disruption and sufficient advantages to gain "buy-in" such as easy usage for people with little computer experience. Lastly, branding the system appropriately, perhaps with a familiar name, makes it more recognizable. During the system's implementation, users must be constantly asked if they have questions or problems and their suggestions for fixing them. Problems that are outside the system's scope, such as not having access to a computer with internet, personal conflicts with other personnel who would like internet access, or equipment failures, should be addressed with administrative personnel.

Political support is integral to the system's dissemination

Unless there is will from the administration to implement an electronic information system, promote its use, and allocate resources to maintain it, there is little chance of success. This system was implemented as part of a scale up strategy between the National Tuberculosis Program and NRL to expand the laboratory network. Political support in this case was demonstrated by the support of the regional health administration and by laboratories providing data entry staff.

Provide adequate training in the system's use and benefits

Training should be focused on the benefits that it provides to the users. In Peru, most previous health information systems have required HC personnel to enter data for reporting purposes without receiving any feedback. While implementing e-Chasqui, we saw reticent users become enthusiastic when they realized the system would provide *them* with useful information. Training must also be provided continually, and the system's use monitored to ensure it continues to meet user's needs.

Ensure the system's sustainability

Sustainability in our experience is maintained by generating user confidence in the system's quality and usability, creating a flexible system able to adapt to changes within the public system, and providing evidence of system benefits. To have user confidence, the system must actually save time and be perceived as a *consistently* useful tool after the initial novelty has worn off. Three main factors to promote sustainability include (1) providing and maintaining a functional internet access point at their HC, (2) ensuring the quality and promptness of data, and (3) providing support to all users. Support to all users usually took the form of technical assistance at the laboratories and up-to-date results to HCs.

Implement the system as part of a larger structural improvement

We believe that the implementation of an information system is enhanced if it is an integral part of larger improvements in the clinical or laboratory infrastructure. That way the system can not only help improve communication but also be part of a more general improvement in workflow. In the case of e-Chasqui, it was incorporated into national project to decentralize DSTs.

Conclusion

Electronic laboratory information systems have much potential to improve patient care and public health monitoring in resource-poor settings. Some of the challenges described, such as lack of trained personnel, limited transportation, and large coverage areas, are obstacles that a well-designed information system can overcome. However, creating well-designed information systems is a difficult task necessitating appropriate resources, expertise and time to be successful.

The purpose of this paper is to pass on our experience of critical design issues and required capabilities to make similar systems work on-site. Though other projects will need to design and rollout laboratory information systems, we hope to make the process less onerous next time around.

e-Chasqui has the potential for creating a national TB laboratory network in Peru to facilitate the communication and analysis of all bacteriological results country-wide. We have already begun to see additional benefits to this system such as having the test always available during clinical decision making, reducing duplicate tests performed, and reducing the time and money spent by staff checking the status of their samples. Studies have been initiated to quantify these benefits. We are also conducting a prospective and retrospective evaluation study to measure e-Chasqui's effect on reducing mean delays, "lost" results with excessive delays, and errors of laboratory reporting. Furthermore, this same system or one similar could more easily be implemented in other countries facing similar problems of test tracking. In our efforts to make these systems available, we are implementing the core functionality of e-Chasqui as a module in the OpenMRS system [27,28]. OpenMRS is a general purpose medical record system architecture we have developed with colleagues in the US and Africa to support TB and HIV treatment programs. OpenMRS is being rolled out in eight countries[29] with support from the US Centers for Disease Control and Prevention and the World Health Organization. At least two of these countries will use the e-Chasqui component.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

JB carried out the design and implementation of the system and drafted the manuscript. SS conceived of the system and helped to draft the manuscript. MY participated in the implementation of the system, its expansion and helped to draft the manuscript. CS, GY and LA carried out the use of the system in the laboratories and health centres in Lima. PC participated in the initial design of the system and the evaluation methodology. HF participated in the design and implementation of the system and helped to draft the manuscript. All authors read and approved the final manuscript.

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Editorial

Medical information systems: A foundation for healthcare technologies in developing countries

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Background

Economic disadvantages in developing countries have resulted in health care per capita spending that is almost two orders of magnitude lower than in developed countries [1]. In addition, tertiary-care hospitals in developing countries typically consume a large proportion of overall health care spending, and less than a quarter of government spending is devoted to public health measures and clinical care in primary care settings [2,3]. Community-based care has the capacity for further reaching impact and has been shown to be effective in treatment and monitoring of HIV (Human Immunodeficiency Virus), tuberculosis (TB), and maternal health in resource-poor settings [4-7]. Reliance on community-based care is likely to become even more important as large-scale, chronic disease management is required for HIV and tuberculosis care in settings where acute care or no care at all, is the norm.

In most developing countries, aside from the wealthiest urban areas, the health infrastructure is currently ill-equipped to meet this increasing demand. Although various technologies have been proposed as elements in the solution of this crisis, it is still unclear which technologies have the highest on-the-ground impact and to which settings they are best suited. More extensive data collection concerning medical needs is required to enable the accurate assessment of the effectiveness of interventions and current health care practices.

In 2004, global health spending reached a total of US$ 4.1 trillion. Ninety percent of this total was spent by the 30 wealthy countries of the Organization for Economic Co-operation and Development (OECD), which make up 20% of the world's population [8]. On average, OECD countries spent more than 11% of their gross domestic product on health, while the countries of the World Health Organization's (WHO) African and South-East Asia regions spent 4.7% [8]. In absolute terms, low-income countries spent US$ 32 per capita on health care in 2004, and high-income countries spent US$ 3,724 per capita. Low-income countries health expenditures fall far short of the US$ 60 per capita that the WHO posits is necessary for an adequately functioning health system [9]. Developing countries, like developed countries, face difficult decisions in distributing limited health-care resources. However, this large health care funding gap makes it even more important that low-income countries have optimal resource distribution.

Poverty itself is one of the principal causes of illness in developing countries, and disease in some low-income regions is a significant barrier to economic growth. Poor health causes a spiral of loss of income and is an inhibitor to education [10], which is itself a barrier to obtaining good health (and making good health decisions). Research commissioned by the WHO found that the economic impact of ill health on individuals and societies is far greater than previously estimated [11]. However, they also go on to state that providing basic health care to the world's poor is both technically feasible and cost effective, potentially saving million lives annually and fuelling development by generating hundreds of billions of dollars in new economic activity every year.

As Saxenian points out tertiary-care hospitals in developing countries, alone may consume 30% to 50% percent of overstretched health budgets [2] (although they generally provide the most specialized and sophisticated services and most clinical research, education, and training). Only a quarter of government spending, and often less, is devoted to cost-effective public health measures and to clinical care that is delivered in local health centers and other community settings. This misallocation means that large subgroups in the population, particularly the rural poor, have extremely limited access to health services. Limited government money means that some primary care level treatments are free but more extensive treatment/care can be very costly and cause households to fall into poverty [9]. The World Bank has stressed the value of the primary health care interventions that are commonly included in programs to reduce childhood malnutrition and mortality, chiefly from infectious diseases. However, several of these highly cost-effective interventions have largely been neglected, including: chemotherapy against tuberculosis; integrated prenatal and delivery care; mass programs to de-worm children; and provision of condoms along with information and education to combat AIDS [9].

A recent report by the WHO projects that, over the next twenty years, HIV/AIDS will account for the greatest burden of disease world-wide, followed by depression and ischemic heart disease. Smoking-related illnesses and HIV/AIDS will be the leading causes of death [12]. However, Mathers also points out that this is based upon the assumption that future mortality and risk factor trends in poor countries will have the same relationship to economic and social development as has occurred in the higher income countries over the last 50 years. If this assumption is wrong, then predictions may be worse. Therefore, in order to best allocate resources, tracking of health care problems and the evaluation of prevention and treatment programs (particularly where HIV/AIDS is concerned) as a function of local economics and social attitudes is essential. Information technology has been proposed as an efficient method for improving the effectiveness and efficiency of health care [13], and has been shown to be particularly useful in the context of outcome improvement, cost reduction [14] and disease intervention [15-20]. This article therefore concentrates, not on what health care programs and devices are likely to be useful, but on how information technology can be employed to improve our understanding of what technologies and practices are needed, while addressing specific problems, such as information loss (and errors), long latencies in delivery, and the cost of health care provision.

Tracking Health Care, Databases and Information Systems

Information technology and electronic medical records (EMRs) have been shown to provide significant benefits in developed countries. Studies have shown that it can improve patient outcomes in the management of renal disease [14,21]. In another recent study of almost a million patients in the Colorado and Northwest regions of the Kaiser Permanente health care system, two years after electronic health records were fully implemented, age adjusted rates of office visits were shown to be 9% lower in both regions [22]. Age adjusted primary care visits were shown to drop by 11% in both regions and specialty care visits decreased by 5% in Colorado and 6% in the Northwest. All decreases were significant ($P < 0.0001$). Wang *et al*. [23] have estimated that the net benefit from using an electronic medical record for a 5-year period was $86,400 US per provider. Benefits accrue primarily from savings in drug expenditures, improved utilization of radiology studies, better capture of charges, and decreased billing errors. A recent long term study of the US Veterans Health Administration (VHA) has demonstrated that EMRs improve efficiency by an estimated 6% per year, and that the only a small number of unnecessary tests or admissions resulted from the usage of their EMR [24].

Although large differences exist between infrastructure and resources for health care in developing countries [25-27], it is possible that EMRs are able to provide similar impacts on health care in developing countries. In fact, given the poor state of medical record keeping in many developing regions, EMRs may even lead to much larger impacts on outcomes, health care efficiency and treatment delivery in developing countries [28-31].

In 2005, Eiseman and Fossum pointed out that available health resource data for developing countries is currently a "patchwork of information at different levels of aggregation and resolution and of varying quality and timeliness that falls short in meeting the needs of the many diverse objectives and organizations that require such data" [32]. Furthermore, "many current data collections rely on labor-intensive collection techniques that require extensive planning and the skills of specially trained teams, which can prove burdensome to those providing the data and may be detrimental to the data's accuracy and timeliness". Eiseman and Fossum and others go on to point out that existing data collections are insufficiently comprehensive, sometimes inaccurate, and often out of date by the time the data can be acted upon [32] ([33]. Without such data, none of the parties trying to address the health problems of developing countries has the required empirical knowledge to inform policy decisions about health resource mobilization and allocation, strategic planning, priority setting, monitoring and evaluation, advocacy, and general policymaking [34-36].

Eiseman and Fossum propose that any global health resource tracking system would contain valid, detailed data (who, what, where, how much) on all health resources (cash and in-kind) provided in previous, current and the next fiscal years to all developing countries by all public and private entities. Furthermore, this should be provided in (almost) real time, without double-counting any resources. Such a system should also have the following ideal properties:

1. Impose on any public or private entity no more than a minimal burden in terms of its provision of the information needed to populate the system.

2. Readily harmonize with and connect to the existing data systems of receiving countries and all donor entities.

3. Be easily accessible via the Web and flexibly searchable by every data element in a variety of languages.

4. Enjoy broad ownership, official buy-in, and use, with long-term support from a diversified funding base.

Eiseman and Fossum point out that this would require that practical data systems already exist in a meaningful way and that they are easily accessible to the relevant users. The reality is that most countries do not use digital health records, and even those who do, often have an extremely limited ability to facilitate searches and exchange data with other systems [37,38]. Furthermore, there is no clear consensus on how the data should be collected, and in what format should the data be stored. These are two key issues in the development of a useful medical health record.

Essentially, there are two possible approaches to the storage of data in an EMR. The first prescribes a top-down national (or international) schema for the medical data, such as the GEHR/openEHR standard, the CEN EN 13606 EHRcom standard, and the HL7 standard. (See Sanroma *et al*. [39] for a good overview of these standards.) The major disadvantages of these approaches are that they are difficult to implement for small projects and are not always suited to primary care-level information collection. An alternative approach is to employ a system that is built from the bottom-up, such as OpenMRS [40-45]. These approaches lead to a streamlined system that provides only for the needs of the project, with little overhead. However, the system is also standardized (for integration with other software, and databases) and extensible so that other data can easily be added to the system.

In both approaches, the EMR should be built with open-source software. This has several advantages over closed proprietary systems. Firstly, the system is more 'future-proof', being able to withstand the changes in libraries, operating systems and hardware. This avoids the problems of having to reverse-engineer data structures and recode interfaces. Furthermore, software can be written in a cross-platform manner, providing maximum choice and flexibility for users. Secondly, open-source software is license free and allows everyone to benefit from any developments made by others, minimizing the costs to everyone involved. Vital funds can then be spent on the support and augmentation of the code base. Use of open-source software can also lead to an increase in competition and allow developing countries to support their own software and applications and the development of related businesses. Examples of such competition stimulation can be seen in the adoption of Linux and Apache by the Apple Corporation. Furthermore, open-source licensing can allow small and medium-sized companies to build a business around the support of medical databases. It should be noted that open-source does not always mean that software is always supplied at no-cost to the user, and such software can be linked to proprietary libraries if the source-code base is distributed under an appropriate license, such as the modified BSD or LGPL licenses. Thirdly, it is generally easier to detect and fix bugs in open-source software, and compliance with standards is more easily enforced. In particular, standards concerning security and protected health information are more easily audited when a system is open.

Since electronic data flow must involve hardware at some point, hardware communication issues must also be considered. The problems of integrating hardware with proprietary interfaces and back-end databases are well-known in the developed world, and these issues do not benefit either the patient or the health care system. That is not to say that private enterprise's role in healthcare in developing countries is unimportant (and we leave this involved discussion for another time), but the foundations of device communication should be sufficiently open in order to maximize the usefulness of any medical record system.

In any EMR, it is also advantageous to include standardized medical languages (such as the Unified Medical Language System; UMLS), which have multiple-language translations, enable multi-lingual versions of the electronic health record and help aggregate data across regions and nations. Errors due to regional differences in the names of drugs, or colloquial terminology for procedures can lead missed opportunities to treat or even to serious medical errors.

Successful technology implementation requires multi-factorial approach

Unlike in developed countries where technology implementation can be focused and rely on existing infrastructure, in developing countries a multi-factorial approach is necessary if technology is going to be implemented and maintained successfully. Among some of the factors that must be taken into account are, corruption, inequalities within the country, imposition of sub-optimal policies or technologies by authorities, and the lack of or incorrect information. Corruption plagues health systems in all countries. In developing countries, one common form is the requisite informal payments to underpaid health staff which creates a significant barrier to care [9]. A 2003 study of the government health system in Albania found that treatment was withheld in the absence of an informal payment and that patients included the estimated costs of informal payments in their decisions to seek care [46,47]. A conceivable offshoot of this established corruption in light of improved health care technology would be the misuse of technology resources or the increase of existing informal payments for their use. In establishing technology-focused health programs in developing countries, monitoring of users as well as data collection and entry must be a significant concern, beginning in the planning stages of program implementation.

In conceptualizing technology-based improvements to health care in the developing world, it is essential to bear in mind the disparities of access and quality of care that currently exist within the health system in any given country and how the planned improvements may exacerbate those inequities. If technological improvements are centered on urban areas, they will likely not impact the health status of the rural poor and, thus, may only marginally benefit the country's overall health indicators [48]. On an implementation level, the strata of the health care hierarchy at which technological advancements will be made are important to consider on the front-end, as this will impact the needed hardware and user-interface. Further, in targeting the end-user population early in the development phases of a technology-based intervention, the health care staff, be they doctors, nurses, or community health workers, can be made a central part of the planning and implementation teams. If the end-users do not perceive a need or value to a new piece of technology, the overall success of implementing that technology will likely be low.

As Malkin [25-27] points out, problems such as rising costs of medical equipment, embedded service contracts, lack of spare parts, lack of required consumables, lack of reliable power and water, lack of public infrastructure such as roads, and lack of technical expertise, plague health care technology in the developing world. While poor infrastructure, such as the telecommunications and electricity grid, should not be seen as justification for relegating improvements in health care technology to the future, the realities of existing capacities must be taken into account. For example, many developing countries have far more reliable wireless than traditional telecommunications systems [49], and technological advancements should focus on those existing strengths. Information and communications technology (ICT) is one area in which developing countries have made significant advancements, and it has been touted as a cost-effective mechanism for delivering health care information in developing countries [50]. In particular, ICT can be leveraged to address the dearth of trained personnel, by both interpreting medical data and facilitating training. With a continually growing rate of over 80% of the world's population living in range of a cellphone tower, telemedicine applications for automated or remote analysis (such as X-ray reading [51]) are becoming increasingly attractive.

In order to illustrate the above points, examples of successful applications of ICT to health care for under-served populations in Peru and Haiti are described in the following section.

The PIH Projects in Peru and Haiti: Health ICT examples in middle and low income countries

In 1996 Partners In Health (PIH), with their Peruvian sister organization, Socios En Salud (SES) and the Peruvian Ministry of Health, started a community-based treatment program for drug-resistant tuberculosis in the slums of Lima, Peru. Multi-drug resistant tuberculosis (MDR-TB) is defined as TB resistant to isoniazid and rifampin, the two most efficacious anti-tuberculous drugs. At that time the few models for treatment of MDR-TB were costly and were centered around referral hospitals. Reported rates of success in middle-income countries and regions ranged from less than 60% in Indonesia and Taiwan [52,53] to just over 80% in Hong Kong, Korea, and Turkey [54-57]. PIH and SES created a community-based project to treat MDR-TB in a resource-poor setting. This new project termed "DOTS-Plus" project built on top of the well-established Peruvian Directly Observed Therapy-Short Course (DOTS) program and treated patients with long-standing disease due to highly resistant strains of TB.

Reported cure rates in this community-based, ambulatory program were as high as any reported in a hospital setting to date [7]. Unlike other cohorts, which had high default rates, all patients in the PIH/SES cohort received directly observed therapy. Adverse effects, moreover, were carefully managed to ensure completion of treatment. Mitnick et al. [7] state that in 1997 "mean treatment costs were US$15,681 per patient, these costs were low at that time – approximately 10% of the costs for hospitalized patients [58,59] – but well beyond the reach of most national tuberculosis programs." Since then advocacy work and pooled procurement have made second-line anti-tuberculous drugs available to countries and programs needing them. Through negotiations with the research-based and generic pharmaceutical industries, the cost of drugs for multi-drug-resistant TB was reduced by up to 98% [60]. By establishing a long-term collaboration and moving treatment into the community, PIH was able to provide high-quality care, lower costs, reduce the risk of nosocomial spread of MDR-TB [61-64], and provide additional, individualized services that patients in low-resource areas may need. Further, this community-based network can be strengthened to provide primary care [65] and be a source of data for further interventions.

The Partners In Health Electronic Medical Record (PIH-EMR) [17], implemented in 2001, was developed to support the two-year MDR-TB treatment regimen for the cohort described above. The PIH-EMR is an example of a web-based EMR based on open-source technology and backed by an Oracle database. The system is viewable in both English and Spanish and currently has over 29,000 patients, 7,600 of which have received treatment. The PIH-EMR includes a clinical record with initial history, physical examination, laboratory results and medications on all patients receiving individualized treatment for MDR-TB. The custom medication order entry system provides advice on potential problems and feedback to the clinical personnel. There is an extensive suite of web-based analysis tools for reporting and outcome monitoring [17]. Analysis tools are used to assess drug requirements based on the medications prescribed and perform operation research. It is also linked to a pharmacy inventory and dispensing system. Evaluations of modules of this system have shown that the medication order entry system produced significantly fewer errors than the previous paper and spreadsheet approach [15]. Drug usage prediction tools have been shown to match the usage data in the pharmacy to within 3% [16] and are used routinely is drug ordering. Further modules have been added to the PIH-EMR to collect and communicate TB laboratory data. A personal digital assistant (PDA)-based system to collect TB lab data from laboratories and health centers without internet was shown to reduce processing delays from 30 to 8 days, reduce errors by 60%, and to be preferred by users [66].

The PIH-EMR has recently been adopted by the Peruvian National Tuberculosis Program for its drug-resistant TB treatment program, and there are plans to expand its use to the entire TB program in Peru. The PIH-EMR is also used to create monthly reports for the Global Fund and the Health Ministry. This experience demonstrates that these types of systems are feasible to implement in resource-poor settings. Another web-based module termed e-Chasqui has been designed and implemented to improve the timeliness and quality of laboratory data [28]. In Peru, the e-Chasqui system has been deployed in the national TB laboratory, two regional laboratories, and 24 pilot health centers. Since its full implementation in March 2006, over 70,000 TB laboratory tests have been entered into the system with over 99% of them viewed online by the health centers. In total, e-Chasqui serves a network of institutions providing medical care for over 3.1 million people at a cost of approximately US$0.53 per sample, the annual total cost is equivalent to 1% of the National Peruvian TB program's 2006 budget.

Since 1999, PIH has run a community-based HIV treatment program in Haiti with its sister organization, Zanmi Lasante, expanding to nine public health clinics in an area with virtually no roads, electricity or telephone service. In these clinics, 'Directly Observed Therapy with Highly Active Antiretroviral Therapy' (DOT-HAART) for HIV is modeled on successful tuberculosis control efforts like the one described previously. Each HIV patient has a community health worker who observes ingestion of pills, responds to patient and family concerns, and offers moral support. Social support – including assistance with children's school fees – is included in services offered. Monthly meetings, in which patients discuss their illness and other concerns, are notable for high attendance [4,67]. In 2006 over 8,000 HIV-positive persons, 2,300 of whom are on antiretroviral therapy (ART), are now followed [68]. Adherence to HAART was very high, and clinical outcomes were excellent: all patients responded with weight gain and improved functional capacity, and fewer than 5% required medication changes due to side effects [69]. As elsewhere, patients receiving HAART are far less likely to require admission to hospital than are patients with untreated HIV disease [70].

The HIV-EMR, an open source web-based system [71], was based on the PIH-EMR. Satellite-based internet access at each site provides access to the system; however, due to the inconsistent power and internet available, an additional offline client for data entry and review was implemented [72]. The HIV-EMR system has been implemented in all sites and currently has over 12,000 patients; 3,051 of which are receiving ART. The system records clinical data including history, physical examination, social circumstances and treatment prescribed. Decision support tools provide allergy and drug interaction warnings and generate warning emails about low CD4 counts. (The lower your CD4 count, the greater the chances of potentially fatal infections.) Staff also keep paper records, but they can use the EMR to check for up to date lab results and drug regimen data and monitor patients' follow-up status. A suite of reporting tools allow staff to create key reports, such as for the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), and automatically generate the reports monthly. Data quality is backed by a monthly checklist of patients and their drug regimens and treatment status that is filled out by the pharmacy and nursing staff and used to update and cross-check the EMR. There is also a full pharmacy inventory system and tools for drug regimen analysis. The inventory system allows pharmacy staff at all clinics to enter stock levels and request drugs and track shipments. This system is used to track 450 products supporting care for 1.78 million patient visits annually. Over the last year drug stockouts have fallen from 2.6% to 1.1% and 97% of stock requests delivered were shipped within 1 day [73]. EMR systems have been shown to provide a better one-year estimate for medication ordering and therefore reduce costs in having stockouts or more expensive, local emergency purchases compared to the current method of ordering based on the last year's estimates [74,75].

Summary

Among the significant barriers to the provision of health care in developing countries, detailed information concerning disease incidence, health practices and available resources (such as drugs for treatment) are some of the most important. Without detailed information concerning the response to health programs, it is impossible to evaluate the efficacy of a particular program and, hence, effectively allocate funding and resources. Although paper-based systems can provide a partial solution, information transmission is slow and prone to errors. Furthermore, aggregation of data is challenging as patient numbers rise into the hundreds [19], and near impossible with thousands of patients. It is also difficult to impose consistent reporting indicators.

The systems described above illustrate the advantages of implementing healthcare technologies within larger collaborations that improve the overall public health infrastructure. One key aspect of the technologies employed in these projects is the use of open standards and open-source development in a collaborative environment.

The cases described in this article also demonstrate the need for community data collection, and feasibility of using ICT to enable data collection, and improve information flow in developing countries. Without such approaches, interventions may exacerbate inequalities within countries with weak infrastructure and ingrained social disparities. However, these systems will only work well with carefully designed forms and interfaces, and excellent data management. Furthermore, EMRs can provide a foundational technology that allows for the adoption and evaluation of other health care technologies, such as drug ordering, medical devices, and longitudinal patient follow-ups. Moreover, the projects described above illustrate that the creation of long-term relationships to build infrastructure and solving systemic problems to provide health care can be beneficial to both the patients and the projects involved.

Abbreviations

AIDS: Acquired Immune Deficiency Syndrome; ART: Antiretroviral Therapy; BSD: Berkeley Software Distribution; CEN: Comité Européen de Normalisation; CD4: Cluster of Differentiation 4; DOTS: Directly Observed Therapy-Short course; DOT-HAART: Directly Observed Therapy with Highly Active Antiretroviral Therapy; EHR: Electronic Health Record; EMR: Electronic Medical Record; GEHR: Good Electronic Health Record; HIV: Human Immunodeficiency Virus; HL7: Health Level 7; ICT: Information and Communications Technology; ICT4D: Information and Communications Technology for Development; LGPL: Lesser GNU Public License; MDR-TB: Multi-Drug Resistant Tuberculosis; MRS: Medical Record System; OECD: Organization for Economic Co-operation and Development; PDA: Personal Digital Assistant; PEPFAR: President's Emergency Plan for AIDS Relief; PIH: Partners In Health; PIH-EMR: Partners In Health Electronic Medical Record; SES: Socios En Salud; TB: Tuberculosis; UMLS: Unified Medical Language System; VHA: Veterans Health Administration; WHO: World Health Organization.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

GDC drafted the editorial and provided the final editing, RHC contributed material and references concerning anthropology and public health statistics as well as editorial assistance, JAB and HSFF made significant changes and provided material and references concerning PIH research in Haiti and Peru. All authors read and approved the final manuscript.

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Research Article

eChoupals: A Study on the Financial Sustainability of Village Internet Centers in Rural Madhya Pradesh

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Abstract

Over the past few years, the long-term sustainability of ICT initiatives has increasingly come under question. Despite persistent doubts, governments, international agencies, NGOs, and private companies are pressing ahead to set up more such projects. This paper studies the financial sustainability of India's largest rural ICT initiative known as eChoupal. *The* eChoupals *are distinct from other telecenter projects in that the value added is not in providing ICT infrastructure alone, but rather, in enabling efficiencies in the agricultural sector through greater information exchange and creation of an alternative market structure.*

An analysis of available data indicates that this project has a potential payback period of 3.9 years. Although several assumptions have been used in these calculations, a sensitivity analysis has been performed to provide a range of possible scenarios that show the profitability of the project. Through this analysis it seems that ICT projects can be financially sustainable when they are viewed not as an end in themselves but as tools to facilitate information exchange whereby, use of the technology enables higher efficiencies in another existing or new business setting, which provides the source of revenue to recover the initial investment.

ICTs and Sustainability

Introduction

The last decade has seen exponential growth in information and communication technologies (ICTs) with computers, digital organizers, mobile phones, Internet, and wireless computing spreading all across the globe. These technologies have unleashed a "cultural revolution in the way individuals and organizations interact, in terms of time, cost and distance" (Munyua, 2000). Apart from changing business and government activities, the potential of these technologies to act as a catalyst to promote socio-economic development in Third World countries has become a popular topic of discussion among development agencies, NGOs, governments, academicians, and experts. The Food and Agricultural Organization of the United Nations noted in one of the earliest books on the topic of ICTs and development that being a "flexible, decentralized, information-sharing tool," the Internet

> offer[ed] the possibility of initiating economic development for agricultural producers, expanding the effectiveness of community development programmes, increasing the amount of participatory research conducted, promoting small business enterprises, and improving news

> media networks. If used as a tool for encouraging two-way communication processes and creating links between people, then it may open up new opportunities for rural people to participate in the global society (Paisley and Richardson, 1998).

In the 1980s, community access points (CAPs) emerged in Scandinavia whereby entire communities accessed computer technology through a shared center known as a *telecottage.* Since the mid-1990s, there has been an explosion of such centers—now called *telecenters*—that deploy Internet technology supported by international and national donor agencies, governments, and even private-sector companies in developing countries. Roman and Colle (2002) from Cornell University characterize this "telecenter movement" as an eclectic process, largely devoid of systematic research and planning. Billions of dollars have been allocated by first-world development organizations, such as the G8, World Bank, UNDP, and bilateral grant agencies, in addition to developing country governments and nonprofit organizations, to set up and sustain these projects. Little careful empirical study, however, has been conducted to evaluate the impact of ICTs on poverty reduction or socioeconomic development. In fact, according to Heeks and Davies (1999),

> failure has been downplayed. . . . estimates suggest that the majority of ICT based initiatives end in *total failure* of a system that never works; *partial failure* in which major goals are unattained or in which there are significant undesirable outcomes; *sustainability failure* that succeeds initially but then fails after a year or so; or *replication failure* of a pilot scheme that cannot be reproduced (authors' emphasis).

In the context of finite and time-bound donor funding, sustainability in the long run and replication (or scalability) of the project are crucial factors. Typically, donor agencies do not expect to fund these projects beyond an initial incubation period, and evaluation of community telecenters focuses carefully on returns on financial and other investments apart from the achievement of initial social objectives (Whyte, 2001). The International Development and Research Centre (IDRC) of Canada demands a strong business plan at the end of a 3-year period, according to Richard Fuchs, director of the Information and Communication Technologies for Development Program Area (Cisler, 2002). The World Bank Development Gateway, the ACACIA initiative of IDRC, the InfoDev program, and the World Summit on Information Society all have sustainability as a vital question on their agenda.

Sustainability

The term *sustainability* seems to have come into common usage as the phrase *sustainable development* emerged in 1987 with the publication of *Our Common Future,* the report of the World Commission on Environment and Development. The commission defined sustainable development as a form of progress that ensures human development and that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). In the realm of development projects, sustainability most often refers to financing of the project in the long run, either from commercial revenue or from continuing donor support.

Some development experts such as Björn Wellenius (2003) of the World Bank argue that telecenters may not be able to achieve commercial sustainability beyond initial public support in poor and rural localities. In fact, demand for financial sustainability may not even be appropriate given that "many places do not have enough people with money to spend on the needed services," writes Cisler (2002) of the Association for Community Networking, even though the projects may be important to the community. Many telecenters face the question of how they can generate income yet serve those in the community who cannot afford to pay for "public goods" kinds of services, such as access to health information (Roman & Colle, 2002).

It is important to realize that donor money spent on ICT projects means explicitly not investing it in other development areas. Heeks (1999) challenges "ICT fetishists" to demonstrate how ICT-based information represents a more important resource than water, food, land, shelter, production technology, money, skills, or power in the development process. Many of these projects are on a pilot, demonstration, or proof-of-concept level, and most literature enumerates positive impacts of information empowerment on a small scale or an anecdotal basis; but one cannot make inferences for the potential impact of ICTs on a larger scale or for the longer term. The opportunity cost of development money is very high and "telecenters that cannot finance themselves in the long run become a drain on public resources. [Moreover], telecenters not subject to market disciplines lack incentives to perform well and the ability to face competition when it arrives," cautions Wellenius (2003). More significantly, if a telecenter is doing well today, can it continue to provide those benefits in the long term? What happens to the project when the funding runs out? If a telecenter does not generate enough revenue to cover operational and maintenance costs apart from generating a surplus to replace equipment, "inevitable equipment breakdowns and obsolescence will eventually force the telecentre to shut down," warns Proenza of the UN's Food and Agriculture Organization (2001).

In addition to financial sustainability, the literature elaborates on social/cultural, political/institutional, and technological sustainability for long-term survival of telecenters. Batchelor and Norrish (2002) define social sustainability as minimizing social exclusion and maximizing social equity. This means ensuring access to the telecentre for heterogeneous groups of people in the community and responding to their different needs. Delgadillo et al. (2002) of the IDRC observe that "if people in the community feel themselves empowered by the telecentre, they will be more active in seeking ways to keep it running."

Political sustainability stems from the recognition that one of the biggest threats to ICT-enabled projects is resistance to change, particularly from vested interests set to lose out in the process of information exchange (Tinio, 2002–2003). Gaining the cooperation of community leaders and policy makers is necessary to create an environment or a "regulatory framework that will protect, promote and support community telecentres and their activities" (Delgadillo et al., 2002).

Technological sustainability is fundamentally related to financial sustainability since the most visible cost usually comprises equipment and technical maintenance. Various projects are trying to adopt modular techniques to make these components of sustainability an integral part of their functioning. Nevertheless, Munyua (2000) notes that "most projects established with external funding face major challenges after the project period has ended. . . . There are as yet few examples of success in attaining such sustainability, and there is an urgent need for viable models to be developed and tested.

This paper is a study of a commercially motivated, rural ICT initiative in the state of Madhya Pradesh in India focusing on the question of financial sustainability. It does not address the questions of social, political, technological, or institutional sustainability, which are perhaps more important. While recognizing this limitation of the paper, the author has chosen to focus on financial sustainability because without it, the project will not survive. The concerns of sociopolitical impact (for instance, impact based on caste, class, gender, and occupation, and the relationship of the project to political and institutional forces in the village, etc.) will be addressed by the author in a forthcoming paper.

ICT Projects in India

The software services export boom in India has been accompanied by another, parallel explosion of projects described by the *Economic and Political Weekly* as "one of the largest set of civil society experiments to use ICTs to empower as well as to increase the range of services to the marginalised at reduced costs" (Vijaybhaskar & Gayathri, 2003). Not only have several state governments and nonprofit institutions started ICT projects such as Gyandoot, Bhoomi, TARAhaat, and Jiva telecenters,[1] but increasingly venture capitalists have entered the fray. A sound business plan, stressing market knowledge, economical use of resources, and revenue generating capacity (Delgadillo et al., 2002), has been the hallmark of these commercially-sponsored ventures, which aim to tap the potential market of 600–700 million Indians living in rural areas by using information technology to provide them with much-needed connectivity and ICT-based services.

This paper undertakes an evaluation of the financial sustainability of India's largest commercial ICT project, started by the India Tobacco Company's

1. Gyandoot: an e-government project started in 2000 in Dhar district, Madhya Pradesh (www.gyandoot.nic.in); Bhoomi: an online land records available through kiosks set up by the government of Karnataka (http://www.revdept-01.kar.nic.in); TARAhaat: an e-commerce portal and telecenters set up by the NGO Development Alternatives (www.tarahaat.com); Jiva Institute: telecenters known as Baatchit that provide education and other services (http://www.jiva.org/enterprise/baatchit.asp).

International Business Division (ITC-IBD),[2] known as the *eChoupals.* The eChoupals are unique in conception and different from the usual telecenter project. Their actual value proposition is the provision of futures' price information and the creation of an alternative buying infrastructure, which is supported by computers and connectivity. Financial sustainability of the eChoupals depends on the ability to recover the investment of the ICT infrastructure but the returns to this project are not from transactions related to the computer but rather from the larger re-engineering of the agricultural supply chain. Most ICT projects set up the infrastructure and then figure out how best to recover the cost of that investment. The struggle is to find viable business propositions by providing information or services through the established network. In contrast, the eChoupals (also known as *soyachoupals*[3] in the state of Madhya Pradesh where the primary rainy/summer season crop is soybean) fundamentally differ from this approach. For the eChoupals, ICTs are not valuable in themselves, but generate value only when they enable the creation of an alternative agricultural infrastructure through the exchange of information, as will be evident from the analysis that follows.

Evaluation of available data on revenue and costs of the eChoupals suggests that this initiative has the potential to be financially sustainable in the long run. The payback period for all capital investment and running costs is 3.9 years. This is exceptional given that most ICT projects are struggling even to recover daily operating costs. A sensitivity analysis shows both optimistic and pessimistic scenarios in Table 6, but in the worst case, payback (without depreciation) is 5.8 years, and in the best case, payback is 3.5 years and the project is able to pay for the replacement cost of the entire capital within 7 years. Several assumptions regarding the correct measurement of capital and operating costs, as well as calculations of savings/revenue, are noted in the paper, which could make the conclusion vary to a certain extent. Despite these problems, it is hoped that this study will encourage further empirical research into the question of the long-term sustainability of ICTs for development.

Research Methodology

In December 2002 and January 2003, the author spent 3 weeks studying the eChoupals,[4] first interviewing ITC-IBD personnel at the firm's headquarters in Hyderabad for 5 days, then traveling to the soyachoupals near Bhopal and Indore in Madhya Pradesh for 14 days, speaking to choupal operators, to farmers, and to villagers using the choupals.[5] Detailed questionnaires for operators, farmers, traders, villagers, and ITC-IBD personnel were developed and used as guides for conducting formal and informal interviews. Group discussions were conducted at tea shops, market places, and village congregation areas (*Panchayat bhavans*), as well as at the choupal premises themselves.

Financial data were obtained from the Hyderabad and Bhopal offices in raw form (from ITC-IBD's online financial management software and from data tables on eChoupal transactions maintained by the financial team in Bhopal) and were amalgamated by the author. This was supported by interviews with ITC-IBD operations, finance, and technical managers, with personnel in two processing plants, and with other field staff. For instance, figures for the average cost of an eChoupal were compared from different sources within the company (see Footnote 1 in Table 4) and also cross-checked with the cost of kiosks set up by other projects studied by the author. Similarly, data on operating costs were obtained from separate sources in Hyderabad and Bhopal and were re-checked in interviews with technical support staff. For revenue/

2. ITC-IBD stands for India Tobacco Company-International Business Division. ITC and ITC-IBD are used interchangeably in this paper to denote the same company.

3. eChoupals, choupals, and soyachoupals are used interchangeably in this paper to refer to ITC-IBD's village Internet kiosks in Madhya Pradesh.

4. Prior to research on the eChoupals, the author spent some time working and researching in Uttar Pradesh (north India) at TARAhaat's village Internet centres started by the NGO Development Alternatives. Following this, the author worked with n-Logue Communications, a company based out of the Indian Institute of Technology, Madras, to set up village Internet kiosks and conceptualize and implement Internet-based services in the south Indian state of Tamil Nadu.

5. See Appendix A for a list of the choupals visited and the characteristics of the villages they serviced.

savings data, the output from ITC-IBD's electronic transaction system, *Entrest,* was calculated at Bhopal by adding up total tons bought by ITC-IBD from all the choupals and using the daily futures' price quoted by ITC. Individual choupals visited by the author were asked to verify the total amount of soybean they had supplied to the company in the last year to see if it tallied with the data in *Entrest* (Appendix A).

The financial analysis was sent to managers in Hyderabad and Bhopal to verify the accuracy of the statistics and claims made in the paper. They suggested a number of corrections, which have been incorporated into the analysis.[6] The data have been put through rigorous tests using conservative discounting rates for the opportunity cost of capital, the failure of monsoons (since the revenue is directly dependent on buying agricultural produce), and differing rates of depreciation. Six scenarios were analyzed, ranging from highly pessimistic to fairly optimistic, based on revenue data from soybean procurement. If other potential revenue streams using the existing infrastructure are added (savings from buying wheat and commission from rural distribution through the same choupals) then profitability in all scenarios is fairly realistic.

The paper is organized as follows. Section two describes the soybean agricultural market structure in Madhya Pradesh followed by the changes brought through the eChoupals and analyzes the benefits accruing to farmers and ITC-IBD (Table 1). The third section and Table 2 enumerate the total revenue for ITC-IBD over a 16-month period and discusses possible sources of revenue in the future. The fourth section presents ITC's variation of the telecenter model and the fifth section enumerates the capital costs and operating costs of the eChoupals (Tables 3, 4, and 5), which have been completely borne by ITC. This is followed by an analysis of the financial data in Table 6 using standard measures of return on investment and payback period to ascertain the financial sustainability of the project. In the last section, this paper provides a brief discussion of the social context of the eChoupals in the villages and reflects upon the potential of this large-scale project to bring about significant changes in rural India.

eChoupal's Proposition

Intermediaries in Soybean Agriculture

ITC-IBD is the 13-year-old agri-business division of the large Indian conglomerate, India Tobacco Company Ltd. ITC-IBD primarily procures and exports agricultural commodities in raw or processed form and is India's largest overall agricultural exporter. With the opening up of Indian agricultural markets in 1996–97 under the World Trade Organization's rules, ITC faced increasing competition from large, low-cost suppliers of agricultural products in the United States, Brazil, and other countries. ITC's procurement costs were much higher due to gross inefficiencies in India's markets, detailed in an influential report on the state of Indian agriculture released in 1997 by McKinsey and Company (FAIDA report; Confederation of Indian Industry and McKinsey and Company 1997). This report lamented India's low productivity and wastage in production and distribution, particularly arising from the small size of landholdings in the country, as a source of higher costs to processors like ITC.

Let us take the example of soybean. ITC-IBD has a network of 130–140 commission agents (CAGs, or traders) in the state of Madhya Pradesh who coordinate the buying of soybean from wholesale market yards (*mandis*) and from a network of smaller traders. ITC-IBD arranges for the processing of all soybean it buys to produce soybean oil, which is sold domestically, and de-oiled cake, which is exported for cattle feed to the Middle East and Southeast Asia. Farmers bring their produce in trolleys, or small wagons, to the mandi, where it is auctioned to a group of traders, some of whom are agents for companies like ITC. These agents weigh and bag the material they purchase, settle the price for the farmer and send the produce to ITC's warehouses for processing. ITC pays its agents a commission along with the cost of bagging and transportation over and above the price of soybean. Farmers, too, have to pay the agents for weighing the produce once it has been auctioned and for labor charges in-

6. ITC-IBD was open and cooperative, both in providing the data and in checking the financial analysis. However, any errors that remain and claims made in the conclusion are the sole responsibility of the author.

volved in moving it to the agent's warehouse. Many agents directly collect the produce of large farmers from the village itself (and get paid extra), while small and medium-sized farmers usually take their produce to the village trader who, in turn, goes to the mandi to sell to larger commission agents, such as ITC.

Given the lack of basic physical infrastructure in the Indian countryside, such as paved roads, cold storage facilities, warehouses, telecom connectivity, etc., and given the geographic dispersion of farmers and the small farm sizes, traders, commission agents, and local mandis have been seen as necessary to ensure the distribution of agricultural produce. These middlemen take the responsibility for quality and bear the financial risk of trading with large numbers of farmers. Often, they are also the brokers of financial capital for seeds and inputs (seed, fertilizer, and pesticides).

Local traders have the power to quote a given price to farmers, as well as the authority to downgrade the price according to their own estimation of the quality of the produce. Manohar Mandloi, an eChoupal entrepreneur from Kurana village, elaborates, "Traders change their prices all day. In the morning they will buy at a higher price, say, one truck for 1,300 Rs. a quintal and another for 1,000 Rs. Over the course of the day, they will keep reducing the price and finally buy several inferior quality lots just for 400–500 Rs.[7] Then they mix it all and sell it for a profit." In this manner, ITC and other companies get a lower overall quality of soybean, which upon processing yields less oil and more contaminated de-oiled cake.

In the mandi, although the auction generally takes place in a competitive manner,[8] prices fluctuate at least 20 rupees per quintal in either direction on a daily basis. Ever since the soybean market in India was pegged to the world price in 1999, however, downward and upward trends have become more difficult to ascertain. Earlier, it was clear that if a farmer was able to hold on to the crop and sell after the season was over (i.e., after January or February rather than in September or October), he would get a better price. Today, with soybean from Brazil and the United States coming on the market at different times of the year, the fluctuation in prices has become uncertain over the course of a year.[9] Traders have information on these price fluctuations through their contact with larger market yards and export companies like ITC, and are able to maximize their own profit margins at the expense of farmers who are unable to predict price changes.

Market Price Information

To lower its procurement cost and improve its quality of soybean, in 2000 ITC-IBD developed the concept of the eChoupal. eChoupals are village Internet kiosks run by local entrepreneurs who provide futures' price information to farmers[10] and enable them to sell their produce directly to ITC, bypassing the middlemen and wholesale market yards (mandis). Through the eChoupals, ITC spends less per ton of produce (since it is not paying commissions and transaction costs to middlemen) and farmers know the price they will receive for their produce if they sell the next day.

Best and Maclay (2002) have called into question the benefits of the provision of market price information for the agricultural sector. They argue that other community characteristics including availability of transport, credit, and alternative markets are important factors that determine whether farmers can act upon the market price information they have obtained. The eChoupal concept has taken this into account by setting up a buying infrastructure parallel to the traditional mandi system. This includes four processing plants and nine warehouses in Madhya Pradesh (that were in operation as of January 2003) where farmers can come directly with their produce, reimbursement of transport costs to

7. One dollar was equal to approximately 50 rupees (Rs.) in 2003.
8. There are certain problems even with the mandi system where the high cost of entry for traders, a monopoly by an influential group of agents, and price fixing are not unknown. Delving into these issues, however, is beyond the scope of this paper.
9. See http://www.cbot.com/cbot/pub/page/0,3181,1288,00.html for historical soybean price volatility at the Chicago Board of Trade. Accessed March 10, 2004.
10. ITC pegs the price for each day based on the previous day's international market rate for soybean. ITC takes a risk in that, if the market plunges the next day, ITC still must honor its commitment to farmers at the quoted futures' price, and incur a loss.

farmers at a fixed rate per quintal,[11] and an entrepreneur (called a *sanchalak*)[12] who runs the choupal in the village helps farmers analyze the price information, and arranges transportation. In many cases, sanchalaks transport the material at their own expense to compete against traders who come to the village and directly negotiate deals with large farmers, thus bypassing the mandi altogether.[13]

The main advantage of ITC's price is that it is a quote for the future. Usually when a farmer sells at the mandi, he has already borne the expense of bringing his produce to market and is forced to sell at whatever rate he can get because it is too expensive to transport the material back to the village and back to market. He may have found out the prevailing rate from returning farmers along the highway or from local trading outposts or even from the local language newspaper in the region, but these prices are for earlier in the day or the prior day. Through the eChoupal, before leaving the village farmers know what price to expect based on a particular level of quality. Moreover, those choupals with Internet access can provide access to world market trends in soybean from the Chicago Board of Trade.[14]

eChoupal versus the Mandi[15]

Once a farmer has decided to sell to ITC, the sanchalak gives him a *sauda* number (transaction slip) that is shown to the officer at the processing plant or warehouse (to be able to track the amount of soybean coming from each choupal). At the plant, the crop is first tested for quality using an electronic machine in the laboratory. Any farmer who contests the results can ask for resampling and retesting of their crop's quality. If the quality is within the limits of 2% bad seed, 2% foreign matter, and 10% moisture, the farmer obtains the highest price advertised the night before. Inferior quality material is downgraded in price by ITC's sampling officer.[16] Once a farmer accepts the price, the produce is weighed on a large, automated scale instead of on a manual scale. In other words, the entire loaded trolley is weighed, then emptied into the silo

11. ITC was setting up choupals in villages more than 100 km away from its four processing plants, making it difficult for farmers to come all the way. So it started an incentive system to pay a certain amount per quintal as freight expenses for every kilometer farmers traveled to reach the plants. ITC also rented nine warehouses in areas away from the four processing plants so that the nearby choupal farmers could travel less to sell their produce to ITC.

12. There are no women operators/entrepreneurs because ITC's selection criteria specifically call for a male operator of a medium-sized farm in the village. A discussion of the gender implications of this choice, while crucial for evaluating the claims of ICT projects to promote overall rural prosperity and socioeconomic development, is beyond the scope of this paper. This topic will be addressed in a forthcoming article by the author that examines the social aspects of the use and benefits of the eChoupals. This paper refers to operators using the masculine gender to draw attention to this important issue.

13. In other cases, ITC's commission agents organize for bulk transportation and get paid an extra commission from ITC.

14. ITC has been experimenting with a system known as Jhangad, *where farmers "sell" their soybean to ITC as soon as they harvest it, and receive 10% of the total price quoted on that day. They also sign a futures' bond whereby on a day of their choice within the next 6 months, the farmers can come back to ITC and collect the rest of the money based on the price prevailing that day. This way, ITC gets the soybean into its processing system and is able to maintain large buffer stocks to use during the lean season; and farmers lacking storage facilities have the option of getting a higher price sometime in the future by paying a nominal fee to ITC.*

15. One of ITC's processing plants was close to the Mandideep mandi (near Bhopal) and competed directly with the mandi for a share of the soybean from the surrounding areas. The largest trader at this mandi complained that they were losing margins and market share to ITC ever since the eChoupals were started. Moreover, ITC had employed an agent to exclusively buy soybean from this mandi for the processing plant. He could bid in the auction up to ITC's quoted price for the day. This created a minimum price cushion under which no other trader could bid and get away with it unless the quality of the material was very poor. Thus, even at this particular mandi, farmers were assured of getting, at minimum, ITC's price for their crop (albeit without the other benefits of freight reimbursements, etc.). Farmers who came to sell specifically at the mandi would often inquire about ITC's price to make sure they were getting the best possible deal.

16. While this may be better than a manipulative trader, there are margins of error in this system. both machine and human. The lab technician pegged the machine at about 3–4% margin of error but did not consider this to be significantly large. Most farmers seemed to treat the lab's analysis as "genuine" compared to the trader's "sight" analysis. While in practice disputes may occur, the author did not have an opportunity to witness such a case.

and reweighed to get the weight of the soybean delivered. In the manual process of the mandi, the material was packed into bags that were then weighed, leaving room for seeds to fall on the ground and excluded from the weighing. Furthermore, the mandi process gave the person balancing the scales an undue advantage to tip against the farmer. Many farmers complained that they would regularly lose 1–2 kilograms per bag (each bag holds approximately 90 kg of material) at the mandi compared with ITC's electronic weigh-bridge. The farmer had to pay the trader in the mandi for *tulai* (labor charges for weighing) and *hammali* (labor charges for bagging and storing). In ITC's case, these services are free, since the grain is directly stored in ITC's silos, instead of being bagged. And finally, ITC gives farmers full payment for produce at the time of the transaction, unlike the mandi, the government-buying center (*Tilansangh*), or even many traders who pay in installments or pay after some amount of time ranging from a few days to a few months. The farmer's cost of selling to ITC is reduced to nearly zero since there is no payment for bagging or weighing, and freight is paid by ITC.[17] ITC-IBD estimates that on average it saves Rs. 275 per ton of soybean purchased through the choupals, while farmers save Rs. 270 per ton. Table 1 shows the average transaction costs incurred both by ITC and the farmer in the traditional system and through the choupals.

Soybean procurement is only one aspect of the larger project of ITC's eChoupal network. ITC also provides updates on the weather and access to lower-priced inputs through pooled purchasing at wholesale prices. Further, ITC has plans over the next several years to use the choupal network to connect farmers to agricultural scientists and to information on best practices to encourage higher productivity. With improving rural incomes, ITC hopes to convert the buying process into a cost-effective rural distribution network selling consumer products, to villagers, such as motorbikes and televisions, and services, such as insurance.

ITC-IBD's Revenue and Savings from the Soyachoupals

Table 2 calculates the savings accruing to ITC over the first 16 months of operation of the eChoupals to December 2002. The data for Year 1 is for the entire year, while the data for Year 2 is for the first 4 months of the season.

From the nearly 73,400 tons of soybean purchased through the eChoupals in the first season (over and above the regular procurement of soybean through ITC's commission agents in the mandis—nearly 30% of all soybean bought by ITC that year), ITC calculated that it saved Rs. 13.3 million in transaction costs or almost 2% of the total value of the produce (Table 2). Moreover, through the choupal system, the produce comes loose in trolleys (usually from a single farm) without being mixed and bagged at the mandi, and is of better quality compared with mandi-procured soybean.[18] Consequently, ITC-IBD estimates saving Rs. 12.9 million in the first year of operation through better quality of oil and de-oiled cake after processing the choupal soybean (Table 2).[19]

Of a total 460 choupals in operation during the first year (September 2001 to June 2002), farmers

17. At certain ITC warehouses where electronic weighing machines are not available, farmers have to pay for manual weighing at the rate of Rs. 3–5 per quintal up to 10–15 Rs. per quintal. Also, at the Indore processing plant, payment for freight was discontinued due to irregularities. Instead, the price per ton was increased by Rs. 20–30 across the board. Many large farmers do not even travel to the mandi to sell their produce since traders negotiate the deal at the village and pick up the material as soon as it is threshed. For these farmers, the opportunity cost of the time they spend transporting the produce is an important component of the cost. Thus, transaction costs for farmers would not be zero in all cases.

18. The choupal material usually comes directly on trolleys and is not mixed or bagged, and is directly unloaded into the silos. Material from CAGs usually comes bagged in trucks, which are then unloaded into huge storage areas covered by tarpaulin.

19. In the first year, ITC ran a separate batch of soybean procured from the choupal through its processing plant and then ran a batch of material from the mandi. The difference obtained in quality was used as the baseline for calculating savings of approximately Rs. 200 per ton. In all, Rs. 7.5 million were saved as crude oil, Rs. 2 million as refined oil, and Rs. 3.4 million as protein content of the de-oiled cake, or a total of Rs. 12.9 million. This data was provided by Raghav Jhawar, finance manager, ITC-IBD Bhopal.

Table 1. Transaction Costs for Farmers and ITC-IBD in Rupees per Metric Ton[1]

	Through the Mandi		Through the Choupal	
	Details of Cost	**Amount**	**Details of Cost**	**Amount**
Farmer Pays	Transport to mandi	100	Transport to Processing Plant[6]	0
	Bagging and Weighing Labor[2]	70	Bagging and Weighing Labor	0
	Labor Khadi Karai[2]	50	Labor Khadi Karai	0
	Handling Loss[2]	50	Handling Loss	0
	TOTAL	270	TOTAL	0
ITC-IBD Pays	Commission to CAG	100	Commission to Sanchalak[4]	50
	Cost of Gunny Bags[3]	75	Cost of Gunny Bags	0
	Labor for Stitching Loading[3]	35	Cash Distribution Cost[5]	50
	Labor for Unloading at Factory[3]	35	Labor for Unloading at Factory[5]	35
	Transport to Factory	250	Transport to Factory (Paid to Farmer)[6]	100
	Transit Losses	10	Transit Losses	0
	TOTAL	505	TOTAL	235
Savings per ton to ITC-IBD is Rs. 275.				

[1]All figures in this table have been estimated by ITC-IBD.
[2]Farmers must pay the laborers who pack their loose material into gunny bags and weigh it. Labor Khadi Karai is payment for moving the bags to the agent's warehouse. Handling loss occurs when the produce is packed into bags and some seeds fall on the ground.
[3]The material from different farmers is mixed by the laborers, put into bags and the bags are stitched up at the agent's warehouse. A truck is hired to transport the stitched bags to the processing plant where another set of laborers unloads them. All this is paid for by ITC-IBD.
[4]Instead of paying CAGs, ITC pays a commission per ton to the person who runs the choupal in the village. This person, called the sanchalak, advertises the choupal to farmers, informs them of ITC's price and the market price, and gives them a transaction slip when they decide to sell to ITC.
[5]Through the choupal system, ITC must pay the farmers and sanchalaks as well as manage large cash flows. ITC has commissioned a bank or its CAGs to do the same.
[6]ITC has started an incentive system to attract more farmers to use the choupals whereby it pays freight charges to farmers as a fixed amount per kilometer for the distance from village to factory.

from 280 choupals sold soybean to ITC.[20] In the second season, starting September 2002, the number of choupals increased to 796 and total procurement at the end of 4 months (through December 31, 2002) was 60,547 tons from the 550 choupals in operation. This was nearly 43.8% of the total procurement for ITC in those 4 months and seems quite large compared with the 73,400 tons in the first year. However, given that most of the soybean is sold by farmers in the early part of the season and that the number of choupals sending in soybean increased from 280 to 550, this procurement was very low. A poor soybean crop yield due to delayed monsoon rains was the main cause. Average output per acre in the second year was close to 3–4 quintals per acre instead of the usual 7–10 quintals per acre. Second, due to increasing price fluctuations in world markets, there were many days when prices in the mandi were greater than those ITC had quoted the previous day (the average price per ton in the second year was approximately Rs. 11,700 compared with Rs. 9,800 in Year 1). Thus, even when farmers had taken the transaction slip from the sanchalak and were on their way to the ITC processing plant or hub, if they encountered a mandi on the way buying at a higher price, they would sell there instead. The financial calculations in section five of this paper take into account the probability of a

20. The season starts with planting of soybean in June–July, and it ends with the sale of nearly 60–70% of the harvest by December–January. The rest of the harvest trickles in until next June when the new planting season begins. September is chosen as the start date for financial calculations because that is when the freshly harvested soybean first comes to market.

Table 2. Cost-Revenue-Savings Analysis of Procurement of Soybean through the Soyachoupals[1]

A	B	C	D	E	F	G	H
Year of Operation[2]	**Quantity of Soybean Bought Through the Soyachoupals (Metric Tons)**	**Quantity of Soybean Bought by ITC Through All Sources (CAG,[3] Mandi, Choupal)**	**Percentage of Choupal Quantity as Part of the Total Soybean Quantity**	**Cost of Soybean Bought Through Soyachoupals**[4] **(Rupees)**	**Cost of Soybean Bought by ITC Through All Sources (Rupees)**	**Number of Choupals In-stalled by Year-end**	**Number of Choupals Active (That Sold Soybean to ITC) by the Year-end**
Sep. 2001 – Aug. 2002	73,400 tons	268,068 tons	27.38%	Rs. 725,000,000	Rs. 3,240,952,712	460	280
Sep. 2002 – Dec. 31, 2002	60,547 tons[5]	138,524 tons	43.79%	Rs. 773,600,000[5]	Rs. 1,778,173,204[5]	796	550
Overall for 16 Months	133,947 tons	406,592 tons	32.94%	Rs. 1,498,600,000	Rs. 5,019,125,916	—	—

[1]The data for this table were provided by Raghav Jhawar, finance manager-Bhopal, ITC-IBD.
[2]The first season for procurement of soybean through the soyachoupals was from Sep. 2001–Aug. 2002. The soya sale calendar is actually from September to June when the next crop is sown. The second season has data only for 4 months.
[3]CAG = Commission Agent. ITC has about 130–140 CAGs in Madhya Pradesh who buy soybean on behalf of ITC at the mandis.
[4]Total Cost is the aggregate Landed Cost for ITC to procure soybean from the Choupals each day. Landed Cost includes price paid to farmer (raw material price), commission to Sanchalak, transportation and bagging (if required), and other associated costs.
[5]Average Price of soybean per ton was Rs. 11,719.79 in Year 2 compared with Rs. 9,890.05 in Year 1. Hence, despite the smaller quantity, the cost was much greater in Year 2. The daily price of soybean seed is governed by international market fluctuations.

Table 2 continued. Cost-Revenue-Savings Analysis of Procurement of Soybean through the Soyachoupals

A	I	J	K	L	M	N	O
Year of Operation[2]	**Transaction Cost Savings for ITC[6]**	**Average Transaction Cost Savings per Ton for ITC[7]**	**Transaction Cost Savings as a Percentage of Total Cost**	**Savings for ITC Through Improved Quality of Choupal Procurement[8]**	**Savings Through Improved Quality as a Percentage of Total Cost**	**Savings as a Percentage of Total Cost**	**Total Value of Savings (Transaction and Quality)**
Sep. 2001 – Aug. 2002	Rs. 13,300,000	Rs. 181	1.83%	Rs. 12,900,000[9]	1.78%	3.61%	Rs. 26,200,000
Sep. 2002 – Dec. 31, 2002	Rs. 12,500,000	Rs. 211	1.59%	Rs. 3,000,000[10]	0.39%	2.00%	Rs. 15,500,000
Overall for 16 months	Rs. 25,800,000	Rs. 194	1.71%	Rs. 15,900,000	1.06%	2.78%	Rs.41,700,000

[6]ITC calculates the difference between the total Landed Cost of soybean bought from the mandi each day vs. one ton bought through the choupal. This is aggregated for the entire season to obtain the total transaction cost savings.
[7]The total transaction cost savings is divided by the total number of tons bought through the choupals to obtain the average amount of money saved per ton. ITC estimates this to be in the range of Rs. 200 per ton. See Table 1 for details.
[8]Since soybean bought from the choupal is usually from a single farmer's field and has not been mixed and bagged with other soybean by CAGs at the mandi, it is of better quality (i.e. moisture, foreign matter, and bad seed are minimal). When this soybean is processed, it provides better quality of oil and deoiled cake. ITC has imputed a value for this quality improvement through comparisons (see footnotes 18 and 19).
[9]In Year 1, ITC ran a batch of soybean procured from the choupal alone through its processing plant and then ran a batch of material from the mandi. The difference obtained in quality was used as the baseline for calculation of savings. Rs. 7.5 million was saved as crude oil, Rs. 2 million as refined oil, and Rs. 3.4 million as protein content of the de-oiled cake. This was corroborated through laboratory sample tests.
[10]The savings through quality in Year 2 were calculated only on the basis of laboratory sample tests and the amount was much lower than Year 1.

good rain year and a bad rain year in determining the profitability of the choupal investment.

Even though total procurement in Year 2 was low (13,000 tons lower than Year 1), the savings from transaction costs were almost at the same level as the first year's transaction cost savings (Rs. 12.9 million, in nominal terms). This was because the price of soybean shot up approximately Rs. 2,000 in the second year (or almost 20% higher), as mentioned earlier. Savings from better quality only amounted to Rs. 3 million, much less than in Year 1 (Table 2, footnote 10).

During Year 1, ITC bought 5,465 tons of wheat from 95 choupals in January to April 2002. This was a trial run for wheat and there were plans to procure many more thousand tons in Year 2. ITC's long-term plan is to make choupals the node for buying all commodities grown in villages in Madhya Pradesh, as well as the distribution centers for agricultural inputs such as seed, fertilizers, pesticides, and such consumer items as oil and insurance. The savings documented in Table 2 do not include wheat procurement or the profits on the sale of inputs and must be treated as partial. In fact, nearly Rs. 45 million of transactions had taken place in input and consumer goods sales over the course of the first 16 months of operation. No substantial data on the savings or commissions to ITC from these input sales were available as of January 2003.

eChoupal: Entrepreneurial Model

Before enumerating the costs of the eChoupals and working out a financial analysis, it is important to understand the technological and business aspects of the village Internet centers. ITC's village Internet centers are run by entrepreneurs selected by the company. ITC's selection process focuses on finding a farmer with a medium-sized operation in a village (this varies from place to place, depending on the average landholding size) who is well-respected and can be an agent of change. Studies have shown that local entrepreneurs are best able to identify and respond to the needs of customers, investigate the market, and promote services to a broad population (Wellenius, 2003).[21] ITC's entrepreneurial model rests on this premise but differs from the usual investment pattern in two distinct ways.

In most small entrepreneur business models, the individual invests in the capital equipment and provides paid services to the entire community to recover the investment. However, in ITC's model, first, the capital investment for the eChoupals is entirely borne by ITC and second, villagers are not charged for any services related to the computer.

ITC covers the capital cost of the computer and Internet connectivity. Even costs such as earthing and wiring of village locations where the computer is to be installed are not left to the entrepreneur. Local start-up costs such as labor and services required to establish the eChoupal as well as training costs for the center owner are also borne by ITC. The entrepreneur incurs only limited operating costs, such as electricity and telephone bills,[22] and occasionally the cost of travel to ITC's processing plant or office for training or for collecting commission payments. An International Telecommunication Union report notes that at the local level the most significant operating costs are salaries for employees and other building-related costs, such as rent, utilities, maintenance, and security (Townsend, 2002). But the sanchalaks did not need to employ someone to run the center because computer use was minimal and most transactions were conducted over the phone. Moreover, all choupals were in the houses of sanchalaks, eliminating rent payment.[23] Nevertheless, the sanchalak is foregoing private use of part of his house as well as bearing security costs, such as building a firm door and installing a lock.

Mr. Sivakumar, CEO of ITC-IBD, explained the ra-

21. Also see R. Kumar & A. Jhunjhunwala, Taking Internet to Villages: Case Study of a Project in the Madurai Region, submitted to the United Nations Centre for Regional Development (UNCRD), August 2002. Accessed 17 November 2003. http://edevelopment.media.mit.edu/SARI/papers/uncrd_report_7.8.021.pdf

22. In places with VSATs, ITC takes care of bandwidth costs but in places with dial-up connectivity, the entrepreneur has to pay for the phone line charges. Currently all price information is accessed through the phone and entrepreneurs pay for that cost from their own pocket.

23. Having the computer inside the house of the sanchalak creates several barriers to access for others in the village, most notably for farmers from lower castes. However, since the price information was being obtained through the phone and being relayed through word of mouth, it quickly becomes public information in the village. Moreover, there is not much general use of the computer, hence this provision has not yet become a large hindrance for pursuing the main objectives of the choupal. Nevertheless, the issue of access is a serious one and will be addressed in a forthcoming paper by the author.

tionale behind this model. First, if an entrepreneur in the village invests his own capital, he expects returns in the short term and on a daily basis. If the stream of income is very small, the entrepreneur is averse to taking further risk. ITC would like the entrepreneurs to "think strategically as a group for long-term prospects such as increasing agricultural productivity and enhancing competitiveness instead of being concerned with short-term returns." In other words, by relieving short-term financial pressures on the sanchalaks, ITC hopes to encourage their deeper involvement in the project of learning how to use ITC-IBD's capital infrastructure and alliances with other organizations to best serve the needs of villagers. Given that sanchalaks as a group are themselves leading farmers in their villages, they are close to ITC's customers and have a good understanding of local market dynamics.[24]

Second, all use of the eChoupal is free for the community and there is no payment to find out prices, weather, or information on best practices in agriculture. The revenue for ITC-IBD is through the transaction and quality savings outlined above, while the revenue for the entrepreneur (sanchalak) comes from a 0.5% commission that ITC-IBD gives him on every rupee of produce sold through his choupal. Charging villagers for accessing prices, best practices, e-mail, etc., would lead to a "transaction-oriented, low-equilibrium approach to ICTs," emphasizes Sivakumar. "The minute you charge, the number of people accessing [the information] will become restricted and eventually you cannot develop customized solutions for all," he argues.

Stoll & Menou assert that a "business model" based on the provision of ICT and related services, on its own, is often not a sufficient basis for achieving financial sustainability. This is even more likely to be the case if the aim is "the development of a community whose members have initially limited requirements for telecommunications and a very low purchasing power, if at all" (2003). ITC-IBD's aim is to provide information for free and thus encourage a change in transaction behavior. In other words, it hopes that farmers will learn about better quality agricultural inputs and order them through the eChoupal, consequently producing a higher quality crop. This way, ITC would obtain further savings through the buying of better quality agricultural commodities as well as commission from the sale of certified agricultural inputs.

It is clear, then, that the revenue for the eChoupal project is not dependent on transactions stemming from the direct use of the computer but rather from a business proposition that has been enabled through the exchange of information. Savings from improved market efficiencies accrue to ITC and are used to defray the cost of capital investment. If the sanchalaks's commission of 0.5% were to be the only source of revenue used in the model, then the sustainability of the entire operation would become questionable.

Financial Analysis of the eChoupal Network

Investment of ITC-IBD

This section, including Tables 3, 4, and 5, outlines the overall investment made by ITC-IBD to set up the choupals. Each choupal consists of a multimedia computer, a printer, and an uninterrupted power supply with solar backup. Connectivity to some places is provided through VSATs (Very Small Aperture Terminals). Research suggests that for both power and Internet charges, costs for solar photovoltaic (PV) power and wireless connectivity will incur lower recurring operating costs as compared to grid power sources and wire line connectivity. Best and Maclay (2002) argue that the savings in operating costs will make up for the added capital costs when amortized over a period of years. ITC seems to have adopted this strategy in pursuing the installation of solar panels and VSATs for power and Internet connectivity. While current capital and operating cost estimates cannot demonstrate reduced overall costs, given that wire line connectivity and grid power are highly unreliable in the region, ITC's proposition seems to make good business sense.[25] The company estimates the average cost of the en-

24. The sanchalak acts as a bridge between the farmer and the technology: he provides information to farmers, sends their queries and concerns to ITC, aggregates their requirements for the purchase of agricultural inputs and consumer products, and physically handles goods through the choupal, that is, stores and distributes these goods. Many sanchalaks go along with farmers to the processing plants to ensure a smooth experience for first-timers.

25. Using wire line connectivity and grid power sources would reduce initial capital costs, but the downtime of these sources would be much greater in the long run. This would increase the downtime of the eChoupal (thus causing loss of potential revenue) and adding costs such as the use of a portable generator.

Table 3. Hardware and Installation Cost of a Soyachoupal[1]

COST of Choupal without VSAT	**Rupees**
Computer with Multimedia	42,000
Dot Matrix Printer	7,000
UPS with Battery[2]	8,000
Solar Charger Panels[2]	9,600
Earthing[3]	4,500
Painting the Choupal Wall[4]	1,000
Insurance and Warranty	3,500
Plaque, Mousepad, Wiring, Miscellaneous	2,000
Keyboard	1,500
Total	79,100
Choupal Cost with VSAT Installation[5]	
Basic Cost of Choupal	79,100
VSAT	90,000
UPS with Battery	8,000
Solar Charger Panel	9,600
Total	186,700

[1]The primary data for this table was obtained from Chander Mohan, head, Technical Services, ITC-Bhopal and Raghav Jhawar, finance manager, ITC-Bhopal. The author received different estimates for the cost of some of the hardware (UPS, solar panels, printers, and VSAT) from two technical support staff and the head of technical services in Hyderabad. One reason for this was the constant reduction in price of hardware and the experimentation with different models to reduce maintenance costs. However, the final numbers have been selected by the author to reflect the average prevailing cost at the time of the study and have also been cross-checked with the cost of kiosks in other projects that the author has studied.
[2]Since most of these villages do not get electricity for more than 6 hours every 2 days, it is necessary to provide an uninterrupted power supply powered by solar panels for the computers.
[3]Earthing is mandatory for the installation of any electronic equipment. Given that most villages get wildly fluctuating power that switches between 2-phase and 3-phase, earthing becomes even more important. ITC-IBD bears the cost of this for every choupal installation.
[4]The outside wall of the sanchalak's house is painted with the logo of soyachoupal to create uniform branding and establish the identity of the choupal.
[5]When installing a VSAT at any location, an additional UPS and solar charger are necessary.

tire set-up as approximately Rs. 80,000 without a VSAT and Rs. 187,000 with one. Table 3 provides a detailed breakdown of the cost.

Table 4 outlines the major capital investments made by ITC-IBD while setting up the choupals. Apart from the basic cost of choupals, this has included the upgrade of telephone exchanges to allow transfer of data over local phone lines. Telecenters in many developing countries have been plagued by delays in getting hooked up to the public telecommunications network, and once connected, suffered from limited bandwidth, poor reliability, and high costs for Internet connections because of a lack of local points of presence (Wellenius, 2003). ITC-IBD has been no exception. Of the 796 choupals established up to December 31, 2002, only 240 had dial-up connectivity after intensive efforts by ITC to install RNS kits in local telephone exchanges (see footnote 5 in Table 4). One hundred of the most promising villages were provided with VSATs, and ITC had plans to install VSAT in every village. Another capital cost was the development of a web portal in Hindi (www.soyachoupal.com) that provides market rate information along with best practices, weather details, and a question-and-answer section. The available data indicate that the total capital investment made by ITC-IBD over the two seasons of soyachoupal operations amounted to approximately Rs. 76 million.

Table 5.1 provides a generic breakdown of operating costs for all 796 choupals over the course of one year (see footnote 2 in Table 5.1 for details of

Table 4. Infrastructure Capital Cost of the Soyachoupals[1]

	Number	Unit Cost in Rs.	Total Cost in Rs.
2001–2002[2]			
Choupals without VSAT[3]	360	79,100	28,476,000
Choupals with VSAT[4]	100	186,700	18,670,000
RNS Kits[5]	130	7,500	975,000
Website Development	1	1,000,000	1,000,000
Total			49,121,000
2002–2003[2]			
Choupals without VSAT[3]	336	79,100	26,577,600
Choupals with VSAT[4]	–	–	–
RNS kits[6]	–	–	–
Website Development	–	–	–
Total			26,577,600
Total for 2 Years			75,698,600

[1]The data for this table was provided by Raghav Jhawar, Finance Manager, ITC-Bhopal; Mr. Chander Mohan, technical services head, ITC-Bhopal; and V. V. Rajasekhar, chief information officer, ITC-Hyderabad. All these costs are approximate figures and this table is not a comprehensive list of all possible capital costs.
[2]Year 1 is the soya calendar from September 2001 to August 2002. Data for Year 2 covers only September 2002 to December 31, 2002.
[3]The breakdown of cost per choupal is given in Table 3.
[4]The breakdown of VSAT costs is given in the second half of Table 3. The total of Rs. 186,700 is obtained by adding the basic choupal cost of Rs. 79,100 and the VSAT cost of Rs. 107,600.
[5]RNS = RAX (Rural Automatic Exchange) Network Synchronization. There are about 2,000 rural exchanges in Madhya Pradesh, of which 256 were providing modem connectivity to ITC's initial set of soyachoupals, but they needed to be upgraded to allow for data transfer. ITC started the upgrade process in June 2001 by installing 130 RNS kits on behalf of the public telecom company Bharat Sanchar Nigam Ltd. (BSNL). BSNL reimbursed the value of the RNS kits at current market price in 2002 causing ITC to incur a loss. ITC also had to bear the manpower costs for installation. The hardware cost is Rs. 12,000 and software cost is Rs. 3,000 per exchange. In the next year, BSNL bought all the hardware and software for 140 more kits that were installed by ITC personnel. ITC had to bear the operating expenses for these installations. This has made dial-up connectivity possible in 240 more villages apart from the 100 that already have VSATs.

this calculation). This includes basic operating expenditure, annual maintenance costs for computers, and bandwidth charges for the VSATs. Table 5.2 provides a sample of operating expenditures for December 2002, which is on the low end (see footnote 2 in Table 5.2). Keniston (2003:8) of the Massachusetts Institute of Technology provides a comprehensive list of the kinds of costs incurred when setting up ICT projects. He focuses on the costs of leadership, planning, and pre-studies, separate from operating costs. The data presented in Keniston's paper do not include the cost of the time and effort of several senior and top management members of ITC-IBD nor the effort involved of midlevel and junior personnel in establishing and monitoring several pilot test choupals. ITC includes these costs in the operational costs for running its regular agricultural procurement and export business.

Payback Period and Sensitivity Analysis

To calculate the profitability of the soyachoupal investment, ideally one would use cash flow data for several years. However, since the project is so young, one has to extrapolate from the 16 months of data that are available. It is clear that such analysis will require several assumptions to be made, which could influence the outcome in different ways. This paper presents a sensitivity analysis using variable rates of risk (probability of monsoons), interest (opportunity cost of money), and depreciation

Table 5.1 Operating Costs of the Soyachoupals[1]

Expenses	Unit Cost in Rs.	Annual Cost in Rs.
Operating Expenditure for 1 Year[1]	Rs. 418,841 average per month[2]	5,026,092
Annual Maintenance Cost[3]	Rs. 55,000 per month for 796 choupals	660,000
Bandwidth Cost for 1 Year	Rs. 21,000 per VSAT for 100 VSATs	2,100,000
TOTAL Operating Expenses for 1 Year	—	7,786,092

[1]The costs included under operating expenditure are only those incurred by ITC for setting up new soyachoupals and maintaining the existing soyachoupal infrastructure. The operating costs incurred for daily trading, buying from commission agents, exporting, and running the main office are not included since they would have been borne by ITC regardless of the investment made in the choupals.
[2]Rs. 418,841 has been obtained by dividing the sum of operating costs from April 2002 until December 2002 (9 months) by 9. The total for 9 months (Rs. 3,769,568) was provided by Raghav Jhawar, finance manager, ITC-Bhopal. It includes 5 months from Year 1 (Sep 2001–Aug 2002) and 4 months from Year 2 (Sep 2002–Dec 2002).
[3]The AMC estimate seems unusually low—only about Rs. 900 per choupal per year. Another estimate of operating costs given to the author was Rs. 1,000 per choupal per month making the total operating cost approximately Rs. 9,552,000. If we subtract the bandwidth and operating expenditure from this number, we can obtain an estimate of the AMC (assuming these are the only three operating costs). This number is Rs. 2,425,908 or approximately Rs. 3,000 per choupal per year. However, using Rs. 9,522,000 as the total operating cost would increase the operating cost used in the calculations by about 20%; but as the revenues are nearly five times the operating costs on average, the reduction in net profit will be only about 5%. Thus, the difference to the overall sustainability of the choupals will not be very large.

Table 5.2. Sample Operating Expenditure for 1 Month[1]

December 2002	Cost in Rupees
Traveling and Staff Welfare	63,376
Vehicles	16,965
Stationery	20,414
Manager's Expenses	20,050
Communication Costs	21,773
Land Rent	65,000
Training	39,882
Miscellaneous	1,590
Total for December[4]	24,9050

[1]The information for this table was provided by Raghav Jhawar, finance manager, ITC Bhopal.
[2]The amount for December is low compared with data for other months, which ranged as high as Rs. 4–8 million. This may be due to reducing levels of procurement as the soybean season's peak ends, or perhaps not many new choupals were established at this time.

(profitability to allow replacement of worn-out equipment) to check for the robustness of the calculations on profitability. Six scenarios are developed in Table 6 ranging from extremely pessimistic to fairly optimistic based on the following assumptions.

First, the eChoupal investment bears high risk because the revenue is completely dependent on the output of agricultural commodities (in this case, soybean), which is dependent on rainfall. This is already evident from the data on revenue where the procurement in Year 2 is very low (even though 796 choupals were installed) as compared to Year 1 (when only 460 choupals had been established). The first year was a relatively normal year for monsoons (though not very good) and the second was practically a drought year, which significantly reduced the soybean output. The calculations for the return on investment take this risk into account by assigning probabilities to rainfall failure. Two scenarios are analyzed: one with a 50% probability of rainfall failure over the course of the project and one with a 20% probability of failure. The 50% probability, which is an extremely pessimistic and highly conservative choice, has been used to see whether ITC's investment turns out to have a reasonable payback period even under such adverse conditions. If yes, then the potential for profitability is much greater.

Second, the opportunity cost of the money invested in the eChoupals must be accounted for in this analysis. Usually the opportunity cost of capital (OCC) is the amount (or percentage) of interest that will be foregone if the capital had been invested in a bank deposit or treasury bonds or even the stock market. Each of these OCC values depends on the interest rate given by the bank or the Treasury but it also includes a risk rate. In other words, while a fixed deposit might give an interest rate of 6%, the stock market will usually give returns around 15% because of the inherent risks of the venture. Thus, the OCC is a cumulative interest rate that includes a savings rate as well as a risk rate. Since this project is quite risky (because of its dependence on the monsoon), we assume at least 10% (6% savings rate plus a 4% risk rate) as a realistic opportunity cost of capital. The value of any profit obtained on this investment has to be discounted by the OCC rate to account for this foregone interest. However, to perform a sensitivity analysis to incorporate lower and higher risk than 10%, two other values of OCC—6% (very safe investment) and 20% (very risky investment)—have also been used in calculations.

Third, it is important to keep enough money aside from the revenue that comes in to replace computers and VSATs once they reach their life span. It is acknowledged that due to pressures within the technology industry to innovate, change products and specifications, and sell new technologies, ICT equipment changes rapidly. Generally, the needs and demands of users of ICT equipment change much more slowly (Cisler, 2002). Thus, it is unknown whether this equipment will have to be replaced over the course of 5 years or 10 years, and depending on which depreciation period is chosen, the profitability of the investment differs significantly. While the percentage recommended by Indian government authorities for tax write-off purposes for computer equipment is 60% per annum from October 2002 onward,[26] this paper conducts an analysis based on two variables of 15% (7-year depreciation) and 20% (5-year depreciation) as a conservative estimate, as we are trying to assess actual replacement needs over time.

Tables 6.1 through 6.6 provide a comprehensive financial analysis of the data on revenue and costs. Table 6.1 calculates net income (profit) and two rates of return on investment. Table 6.2 includes the probability of monsoon failure and provides two weighted rates of return on investment that are used to calculate future streams of profit in Table 6.3. Table 6.4a and 6.4b calculate the present values of investment and profit after each year (for a total of 7 years) using three rates of the opportunity cost of capital to enable comparison for the final calculation of net present value of the investment and the payback period.

Table 6.5 provides the calculations of the net present value (NPV) of the investment from Year 4 to Year 7 to see how long it takes to recover the initial investment (net present value becomes positive) using the three OCC rates. At the point where the NPV is zero, the project has completely paid for itself. The amount of time taken for this is known as the payback period. As the OCC rate rises (from 6% to 10% to 20%), it takes longer for the project to achieve a positive NPV and the payback period increases. Similarly, using the 50% rainfall failure scenario, the payback period is much longer as compared with using the 20% failure rate.

The most realistic scenario is a payback period of 3.9 years with an OCC of 10% and probability of monsoon failure at 20%. However, even in the worst case scenario with an OCC rate of 20% and a 50% rainfall failure probability, the payback period is 5.8 years. The project does seem to be financially sustainable, but the analysis so far has not included the cost of depreciation. The project will have to replace capital equipment (computers and other

26. Visit http://www.financialexpress.com/fe/daily/19991020/fec20001.html which lists the depreciation rate for computers under the "Plants and Machinery" category at 25% (for tax write-off purposes). Visit http://www.helplinelaw.com/news/1002/d_deprate1002.php for the amendment to the Income Tax Act, which states that computers as a separate category are entitled to depreciation at 60% per annum since October 2002.

hardware) as it gets obsolete or breaks down over the course of the 7-year period. Can the profits sustain this new investment at repeated intervals? Table 6.6 compares the cost of re-investment at the end of 5 years and 7 years with the NPV of the project. At the end of a given number of years, the value of the NPV is the amount available to be re-invested in replacing equipment at that time. It is clear that only in the most optimistic scenario using 6% OCC and 20% monsoon failure is there sufficient money left over at the end of 7 years to pay for replacement costs entirely. In the realistic scenario of 10% OCC and 20% monsoon failure, about 83% of replacement costs can be covered at the end of 7 years but only 31.5% can be covered at the end of 5 years. While this means that the overall profitability of the project is reduced, the discussion in the next section analyzes other sources of revenue that could help the project achieve long-term sustainability.

Discussion on Financial Sustainability

The calculations in Tables 6.1–6.6 give us a static financial picture at the end of December 2002, whereby ITC-IBD, with no further investment and no changes in operations over time, would recover its costs within 3.9 to 5.8 years, depending on the assumptions used. However, the profitability of the project in the calculations has only used revenue figures from soybean procurement. ITC-IBD had already initiated the procurement of wheat from the choupals in Year 1 and was gearing up for massive buying in the months from January to April 2002.[27] The addition of revenue from wheat would change the calculations significantly, given that wheat is a larger tonnage crop in Madhya Pradesh compared to soybean.[28] Even more important, the choupals had become distribution centers for a variety of agricultural and consumer products like seeds, pesticides, fertilizers, soybean oil, and even insurance. The commission accruing to ITC-IBD from these sales is potentially significant, but it is unknown and therefore has not been included in the calculations.

Clearly, since the eChoupals have only been in full operation for less than 2 years, and since potential revenue from wheat procurement and input sales could be substantial, the possibility for payback in 3.9 years using the soybean data alone gives confidence that the choupals are well on their way to financial sustainability.

Several cautionary notes are in order. ITC-IBD itself suggests that the savings from transaction costs and quality improvement will decrease over time and die out in a few years because of increased efficiencies in the market and greater competition from middlemen and other companies.[29] Instead, ITC's expectation of a long-term source of revenue is not primarily from procurement but from the sale of consumer goods and agricultural inputs. Since this evaluation of sustainability is based on a linear extrapolation for 7 years, if these transaction savings go down, sustainability will be negatively impacted. And since there is no data yet available for commission revenues from rural distribution of agricultural inputs and consumer goods, it cannot be said for certain how the project will shape up in the future.

Next, there are questions with the quality data used as part of the savings calculations in Table 2. In the first year, apart from conducting laboratory sample tests, ITC ran a batch of eChoupal soybean and regular soybean through its processing plant in Indore. Data on the quantity of soybean tested, detailed percentage breakdown of quality improvement, margins of error, and the method used to obtain numerical values for savings are not available. The data for Year 2 are significantly lower and are based only on laboratory sample testing. Using the first year's percentage of 1.78% savings, the savings from quality in Year 2 increased by 4 times compared with the actual value of Rs. 3 million. While there have been improvements in quality, they could fall within the range of 0.5% to 2.0% of the price of soybean bought. This is a very large range, and unfortunately, more precise data were not available.

Finally, and this is the most important, most of

27. January is the start of the wheat harvest and most farmers sell their produce within 4 months of the harvest.
28. See http://www.kisanwatch.org/eng/statistics/aug.02/stat_area_prd_soyabean.htm and http://www.kisanwatch.org/eng/statistics/aug.02/stat_area_prd_Wheat.htm Accessed April 13, 2003.
29. Already ITC's competitor companies like Ruchi Soya and Savariya Soya have set up their own computer centers in some villages and are on a massive advertising campaign to attract farmers with higher prices and value-added services like pick-up from home. Local traders in small towns have also responded by opening branches closer to villages and village traders have been forced to quote a higher price even to very small farmers lest the latter go to the choupal and sell the material to the sanchalak (who amalgamates these 1–2 bag sales and takes them together to ITC).

Tables 6.1 to 6.6. Calculation of Financial Returns from the Soyachoupals

Table 6.1 Calculation of Net Income (Profit) and Rate of Return on Investment for Year 1 and Year 2

	Year 1 (Sep. 2001–Aug. 2002)	Year 2 (Sep. 2002–Dec. 2002)
Investment Made Each Year[1]	49,121,000	26,577,600
No. of Choupals Added Each Year	460	336
Total Choupals in Operation During the Year	460	796
Revenue[2]	26,200,000	15,500,000
Operating Costs[3]	4,449,500	2,595,364
Net Income (Profit)[4]	21,750,500	12,904,636
Rate of Return on Investment[5]	44.28%	17.05%

[1]The capital investment figures come from Table 4. The cash flow values in this table are all nominal (not discounted for inflation) and will be discounted in Table 6.4 for using different nominal rates of interest for the calculation of net present value and payback period.
[2]The revenue figures come from Table 2, Column O. The figures do not include anticipated revenue from the procurement of wheat or sale of inputs.
[3]Operating costs come from Table 5. The figure in Table 5 is a cumulative annual cost for 796 choupals (Rs. 7,786,092). In the first year, only 460 choupals were in operation, hence this figure has been adjusted linearly to reflect fewer numbers of choupals. For the second year, even though 796 choupals were in operation, our data is only for 4 months. Hence the overall number from Table 5 is discounted for 4 months.
[4]Net income (profit) has been calculated using the simple formula Profit = Revenue − Operating Costs for Year 1 and Year 2.
[5]Profit is divided by investment in Years 1 and 2 separately to obtain two annual rates of return on investment (ROI). The ROI in Year 1 is designated as a Good Rain Year ROI (GRY) while the ROI in Year 2 is designated as a Bad Rain Year ROI (BRY).

Table 6.2 Calculation of Rate of Return on Investment Using Factor Probability of Monsoons in India[1]

Probability of a bad rain year	Calculation	Weighted ROI
Every Other Year (50%)	Weighted ROI = (GRY[2] × 0.5) + (BRY[3] × 0.5)	30.66%
1 in 5 Years (20%)	Weighted ROI = (GRY × 0.80) + (BRY × 0.20)	38.83%

[1]The rate of return on investment is adjusted using a factor of probability of the monsoons to obtain an average annual rate of return that can be used to calculate future values of profit. An extremely conservative estimate assumes a 50% chance of monsoon failure, thus weighting the ROI from Year 1 and Year 1 equally. A more realistic estimate assumes monsoon failure at 20%, or once in 5 years.
[2]GRY = Good Rain Year.
[3]BRY = Bad Rain Year.

Table 6.3 Estimation of Future Streams of Profit Using Weighted ROI at 50% and 20% Rainfall Failure Probability[1]

Profit Streams	Using 50% Rainfall Failure Weighted ROI	Using 20% Rainfall Failure Weighted ROI
Year 1 Actual Profit	21,750,500	21,750,500
Year 2 Actual Profit	12,904,636	12,904,636
Year 3 Estimated Profit	24,140,244	30,571,898
Year 4 Estimated Profit	25,105,854	31,794,774
Year 5 Estimated Profit	26,110,088	33,066,565
Year 6 Estimated Profit	27,154,492	34,389,227
Year 7 Estimated Profit	28,240,671	35,764,796

[1]*This weighted rate of return on investment is used to calculate constant future streams of profit for 7 years. This is done by adding the total investment made in Year 1 and Year 2 and multiplying this by the weighted ROI. The estimated profits from Years 3 to 7 are adjusted for inflation, since this is a nominal value.*

To calculate inflation rate, the Wholesale Price Index has been obtained from "The Consumer Price Index Numbers for Industrial Workers—All-India (Base: 1982 = 100)" table available at the Reserve Bank of India website http://www.rbi.org.in/index.dll/34044?OpenStoryTextArea?fromdate=06/30/97&todate=03/12/03&s1secid=70&s2secid=0&secid=2/70/0&archivemode=2). The 2000–2001 index is 444, while 2001–2002 index is 463. The year is calculated from April to March. Actual inflation is calculated to be 4.28%, but 4% is used for ease of calculation.

Table 6.4a. Calculation of Present Value of Investment[1] *Using Different OCC Rates*[2]

	Nominal Value of Investment	Present Value @ 6% Discount Rate	Present Value @ 10% Discount Rate	Present Value @ 20% Discount Rate
Year 1 [3]	49,121,000	49,121,000	49,121,000	49,121,000
Year 2[4]	26,577,600	25,073,208	24,161,455	22,148,000
TOTAL Initial Investment		74,194,208	73,282,455	71,269,000

[1]*To obtain a cumulative present value of total investment, the investment in Year 1 and Year 2 need to be added together, but only after obtaining their present value. This figure will be used to calculate Net Present Value of the investment (by subtracting it from the Present Value of cumulative profits) at the end of a given number of years.*

[2]*The Opportunity Cost of Capital (OCC) must be taken into account when calculating the present value of any investment. To perform a sensitivity analysis, three values of OCC—6% (very safe investment), 10% (risky investment), and 20% (very risky investment)—have been used in calculations in Tables 6.4a and 6.4b. The OCC rate is also called the discount rate.*

The Fixed Deposit Savings rate of ICICI Bank is 6% and has been used as the baseline savings rate for discounting. See www.bankofindia.com/interest_rates.html and www.icicibank.com/pfsuser/icicibank/depositproducts/fixeddeposits/interestrates.htm which provide fixed deposit interest rates for deposits of more than Rs. 10 million for more than 1 year at 5.50% per annum and 6.0% per annum.

[3]*Investment in Year 1 is made at the start of the year, that is, Time (t) = 0. Thus, it is not discounted.*

[4]*Investment in Year 2 has been made at t = 1 (or at the start of the second year) so it is discounted only for one year (and not 16 months) to get its Present Value in t = 0.*

Table 6.4b. Calculation of Present Value of Profit[1] Using Three OCC Rates[2]

	50% Rainfall Failure Weighted ROI			20% Rainfall Failure Weighted ROI		
	Present Value @ 6% Discount Rate	Present Value @ 10% Discount Rate	Present Value @ 20% Discount Rate	Present Value @ 6% Discount Rate	Present Value @ 10% Discount Rate	Present Value @ 20% Discount Rate
Year 1 Actual Profit [3]	20,519,340	19,773,182	18,125,417	20,519,340	19,773,182	18,125,417
Year 2 Actual Profit [4]	11,935,475	11,353,052	10,406,965	11,935,475	11,353,052	10,406,965
Year 3 Estimated Profit	20,268,614	18,136,923	13,970,049	25,668,755	22,969,119	17,692,070
Year 4 Estimated Profit	19,886,188	17,147,636	12,107,376	25,184,439	21,716,258	15,333,128
Year 5 Estimated Profit	19,510,977	16,212,310	10,493,059	24,709,261	20,531,735	13,288,711
Year 6 Estimated Profit	19,142,845	15,328,003	9,093,984	24,243,048	19,411,822	11,516,883
Year 7 Estimated Profit	18,781,659	14,491,930	7,881,453	23,785,632	18,352,996	9,981,298

[1]*The present value of the profit obtained over a given number of years is required to be able to add up these values and derive a cumulative profit value at the end of a certain period of time. The present value of investment is subtracted from this cumulative profit value to obtain the net present value of the project.*

[2]*The value of any profit obtained on the eChoupal investment has to be discounted by the OCC rate to account for the interest foregone. Since our project is risky (because of its dependence on the monsoon), we assume at least 10% (6% savings rate plus a 4% risk rate) as a realistic opportunity cost of capital. However, to perform a sensitivity analysis to incorporate lower and higher risk than 10%, two other values of OCC, 6% (very safe investment) and 20% (very risky investment), have also been used to discount the profit values.*

[3]*Year 1 profit has been obtained at the end of the year, hence it needs to be discounted for one year (divided by one year's OCC rate) to find out its Present Value in Time (t) = 0.*

[4]*Net Present Value of Year 2 Profit in Time (t) = 0 is calculated by dividing Year 2 profit by a 16-month rate of return since it has been obtained at the end of 16 months. This 16-month rate of return is calculated by multiplying the annual OCC rate of return by 4/12 and adding 1, which gives us a 4-month discount and multiplying this by 1 plus the annual OCC rate of return.*

Table 6.5 Calculation of Net Present Value (NPV)[1] and Payback Period[2] of the Total Investment

	50% Rainfall Failure Weighted ROI			20% Rainfall Failure Weighted ROI		
	Present Value @ 6% Discount Rate	**Present Value @ 10% Discount Rate**	**Present Value @ 20% Discount Rate**	**Present Value @ 6% Discount Rate**	**Present Value @ 10% Discount Rate**	**Present Value @ 20% Discount Rate**
Total Profit After 4 years	72,609,617	66,410,793	54,609,805	83,308,009	75,811,612	61,557,579
NPV of Investment After 4 years	(1,584,590)	(6,871,662)	(16,659,195)	9,113,801	2,529,157	(9,711,421)
Total Profit After 5 years	92,120,594	82,623,103	65,102,864	108,017,269	96,343,347	74,846,290
NPV of Investment After 5 years	17,926,386	9,340,649	6,166,136	33,823,062	23,060,892	3,577,290
Total Profit After 6 years	111,263,439	97,951,106	74,196,849	132,260,318	115,755,169	86,363,173
NPV of Investment After 6 years	37,069,232	24,668,651	2,927,849	58,066,110	42,472,714	15,094,173
Total Profit After 7 years	130,045,098	112,443,036	82,078,302	156,045,950	134,108,164	96,344,471
NPV of Investment After 7 years	55,850,891	39,160,581	10,809,302	81,851,742	60,825,710	25,075,471
Payback Period	4 years	4.5 years	5.8 years	3.5 years	3.9 years	4.9 years

[1]*NPV = Net Present Value. (Cumulative Profit − Initial Investment) has been calculated starting from Year 4 onward and turns from being negative (where the cumulative profit is still less than the initial investment) to positive (when the cumulative profit is greater than the initial investment).*

[2]*The number of years required to reach the point at which the cumulative profit equals initial investment is the payback period of the investment. Using variable rates of discounting for the opportunity cost of capital (to take into account the risky nature of the project), different payback periods are obtained. See the section: Payback Period and Sensitivity Analysis.*

Table 6.6 Depreciation Analysis for Two Rates of Replacement[1]

	50% Rainfall Failure Weighted ROI			20% Rainfall Failure Weighted ROI		
	Present Value @ 6% Discount Rate	Present Value @ 10% Discount Rate	Present Value @ 20% Discount Rate	Present Value @ 6% Discount Rate	Present Value @ 10% Discount Rate	Present Value @ 20% Discount Rate
Scenario A						
NPV of Investment After 5 Years[2]	17,926,386.45	9,340,648.65	(6,166,135.79)	33,823,061.78	23,060,892.04	3,577,290.09
Year 5 Proposed Investment[3]	74,194,207.55	73,282,454.55	71,269,000.00	74,194,207.55	73,282,454.55	71,269,000.00
Percentage of Replacement Investment That Can Be Made Using Profits	24.2%	12.7%	(8.7%)	45.6%	31.5%	5.0%
Scenario B						
NPV of Investment After 7 Years[2]	55,850,890.82	39,160,580.96	10,809,301.55	81,851,742.17	60,825,709.85	25,075,470.97
Year 7 Proposed Investment[3]	74,194,207.55	73,282,454.55	71,269,000.00	74,194,207.55	73,282,454.55	71,269,000.00
Percentage of Replacement Investment That Can Be Made Using Profits	75.3%	53.4%	15.2%	110.3%	83.0%	35.2%

NPV = Net Present Value.

[1]The calculation of payback period is incomplete without an analysis of depreciation. It is clear that the project will have to replace its capital equipment (computers and other hardware) at some point. High profitability will imply that the cost of this new investment will be completely covered through future streams of profit over and above recovering the cost of the initial investment. If future profit cannot produce enough capital to make this replacement, then profitability is lowered. Two scenarios are recreated here using two rates of depreciation; Scenario A uses 5 years as the time required to replace all capital and Scenario B uses 7 years.

[2]Net Present Values for Year 5 and Year 7 have been taken from Table 6.5.

[3]Future investment required in Year 5 and Year 7 has been calculated by multiplying the total nominal investment for Year 1 and Year 2 by the inflation rate. This has been divided by the OCC rate to obtain the present value of the investment to compare with the NPV.

the transactions and information exchanges for prices and setting up sales (transaction slips) were not being conducted via the computer and Internet. In fact, in places where the choupal was functioning, most data transmission (information exchange) took place through the telephone owned by the eChoupal operator himself. Thus, the savings calculated do not reflect the returns on investment from ICTs.[30] In this project, ICTs are a catalyst for (or an instrument of) the process of improving transaction flows by disintermediating and bringing efficiencies into the agricultural value chain. The resultant savings are not a direct result of the technology, which was not in general use at all. Rather, efficiencies improved because the process of information exchange resulting from introducing the technology led to the rationalization of production flows. Thus, it is not the computers, email, and Internet that are generating these savings but the elimination of inefficiencies from the market. Technology is a catalyst for another process, which is social and economic, and to argue that all this has been because of computers would not be accurate.[31]

Conclusion

This paper has not attempted to outline or evaluate the impact of the soyachoupals on their primary users, namely the farmers in rural Madhya Pradesh. In the author's interviews at the village level, it became apparent that caste affiliations, political alignments, and even the size of one's farm were important issues that influenced access to the eChoupals and determined to what extent farmer incomes were changing. Moreover, eChoupals had only been established in larger and more prosperous villages so their reach into the poorer and remoter parts of rural India is still an open question. Concerns were also raised regarding the possible market monopoly by ITC-IBD in the future, given that the alternative mandi system and local traders were losing market share and their business was being greatly threatened.[32] While recognizing the limitations of this paper in leaving out these important social, economic, political, and cultural issues, the author concentrates on financial sustainability because without it, the project would close down and there would be no question of studying impact on the people.

ITC-IBD is itself convinced of the sustainability and scalability of the eChoupal model. It recently adopted an ambitious 5-year plan to establish 20,000 choupals in the country. It seeks to modify and refine the eChoupal model as it expands into other states and starts buying other crops. There are several challenges. First, ITC itself believes that the profitability of the choupals will diminish over time because the information revolution of the eChoupals cannot be confined to the choupals alone. Other companies have already picked up the process of rationalization and disintermediation, but ITC is prepared for continuous changes of its system of information delivery and potential competition is part of company planning. Second, despite a sensitivity analysis and obtaining a range of payback periods, the analysis of financial sustainability in this paper is based on limited availability of data and contains a significant amount of extrapolation to the future. This needs to be taken into consideration when one examines the results. Third, the project is running on the basis of enthusiastic, talented people who have taken it upon themselves to ensure its success. The cost of their time and energy, especially since the choupal responsibility is in addition to their regular work of export trading and procurement, is not included in these calculations. This omission becomes crucial as the company expands and more

30. ITC argues that transactions have been higher from eChoupals with satellite connectivity compared with eChoupals without satellite connectivity (or no connectivity at all), implying that the presence of a connected computer made a significant difference in encouraging farmers to try out the new system. However, several factors are involved in determining activity levels of choupals, including the distance from processing plants, choice of operator (sanchalak) and his entrepreneurial ability, level of soybean harvest, etc., making it difficult to isolate the impact of connectivity alone.

31. This brings up an interesting question: Is the telephone sufficient to produce these kinds of market efficiencies? In other words, would investment in call centers be more "appropriate" on the part of ITC rather than expensive computers and VSATs? Most of the interviewees at ITC-IBD pointed out the unique ability of transmitting volumes of information to a number of places through computers and the Internet, especially when it came to providing information on best practices and setting up consultancy with remote agricultural scientists. Further research into the costs and benefits of both these technologies (it has not been undertaken as part of this study) will be useful to explore the value-added by high-end ICTs and perhaps justify the popular deployment of computers as the technology of choice.

32. These are critical questions and the author hopes to address them in a forthcoming paper.

people are recruited to handle larger numbers of eChoupals. ITC is aware of the challenge to maintain the initial level of enthusiasm and to train new people to align with their vision as they move toward 20,000 choupals. Internal training sessions and a knowledge management system, while in place, are yet to be fully implemented at the field level to collectively pool the learning of many field workers in the expansion process.

Despite all these challenges, what is impressive is that after 16 months of operation, the eChoupal project seems to be not only self-sustaining, but in fact, profitable. A number of factors promise to keep it self-sustaining. Already, there are ongoing efforts to use the choupals to procure additional crops in the yearly crop cycle and for bulk sale of cheaper agricultural inputs. Both activities propose to benefit farmers and to help ensure year-round transactions and commissions for ITC and the operators. Second, with additional training and by removing connectivity hurdles, the computers installed in the villages will be used to conduct these transactions, thus introducing new economies of scale. Moreover, ITC believes that computers will play a vital role in disseminating agricultural best practice information and connecting farmers to agricultural scientists for consultancy—an ambitious aim to encourage higher farm productivity and improve the overall competitiveness of Indian agriculture. Third, ITC has long-term plans to use this network for the sale of other products, such as motorbikes and insurance, which entails a commission to the company. And finally, given a computer network of 20,000 nodes, there are possibilities of using this infrastructure to disseminate noncommercial information to rural areas more effectively. All these are positive elements on the side of ITC that will strengthen the sustainability of the eChoupals.

The data presented here and the promise of the future have prompted India's largest agri-exporter to make a huge investment in this previously untried and untested domain. With dedicated and enthusiastic personnel, with a desire to learn from mistakes, and with a clear vision, the eChoupals may become the largest successful ICT initiative in India. It is essential, however, that this research is placed within the context of the larger debate on ICTs and development. For that, further studies are required to understand the impact of the eChoupals on the lives of rural women, small and medium-sized farms, agricultural laborers, lower castes, and the destitute, especially as the eChoupals expand to cover much of India. Only then will it be possible to understand to what extent ICTs can contribute to changing the life of the rural poor in the long run. ■

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Appendix. Profile of the eChoupals Visited During This Research

Choupal	Quantity Supplied to ITC in 2002 Season	Quantity Supplied to ITC in 2001 Season	Date of Installation	VSAT	Tehsil*	District*
AbdullaBarkhedi	0	0	09-May-01	—	Bhopal	Bhopal
Bagroda	25.395	17.18	14-May-01	Yes	Huzur	Bhopal
Bala_Barkheda	6.43	—	24-Apr-02	—	Vidisa	Vidisha
DoubleChowki	439.915	2103.365	20-May-01	Yes	Dewas	Indore
GoharGanj	0	—	25-Apr-02	—	Goharganj	Raisen
Kalwar	0	—	18-Jun-02	—	Kannod	Dewas
Kamlapur	(not available)	707.865	16-Sep-01	Yes	Bagli	Dewas
Karnawad	427.705	241.59	19-May-01	Yes	Bagli	Dewas
Khasrod	135.293	199.063	08-Dec-00	Yes	Gourganj	Raisen
Kurana	222.645	8.145	14-Nov-01	Yes	Bhopal	Bhopal
Matmore	352.885	228.45	16-Sep-01	—	Bagli	Dewas
MungaliyaChap	273.195	344.005	10-Sep-01	Yes	Bhopal	Bhopal
ParwaliyaSadak	1017.61	31.88	18-Apr-01	Yes	Huzur	Bhopal
Rapadiya	22.975	0	21-May-02	—	Huzur	Bhopal
Salamatpur	216.81	33.695	26-Nov-00	Yes	Raisen	Raisen
Tumda	139.775	0	15-Dec-01	Yes	Huzur	Bhopal

Note: Villages were chosen based on the following criteria: (a) amount of soybean delivered (active/inactive sanchalak), (b) Internet availability, (c) education level and age of sanchalak, (d) size of sanchalak's landholding, (e) village population, and (f) distance of the village from major towns and highways.
** Districts make up a state; tehsils make up a district.*

Appendix (continued)

Total Choupal Population	Total Number of Farmers in Choupal	Total Acreage Under Choupal	Bank	School Until X Standard	Hospital	Government Soybean Buying Centre	Cooperative Center
800	100	1,500	Yes	8	—	—	—
3,000	300	2,800	—	8	—	—	—
1,400	200	2,000	Yes	8	Yes	—	—
3,000	40	500	Yes	12	Yes	Yes	Yes
4,000	1,500	2,200	Yes	12	Yes	—	Yes
3,000	300	3,000	—	5	—	—	Yes
4,500	700	12,000	Yes	12	—	—	—
1,000	955	3,500	Yes	12	Yes	—	Yes
400	30	700	—	5	—	Yes	Yes
1,500	100	1,327	—	8	—	Yes	—
2,000	200	1,500	—	8	—	—	—
5,000	500	3,000	Yes	12	Yes	Yes	Yes
1,200	100	3,000	Yes	10	—	—	Yes
1,000	250	1,000	—	8	—	—	Yes
3,824	1,044	286	Yes	12	Yes	—	Yes
7,000	350	3,000	Yes	10	Yes	—	Yes

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Research Article

Text-Free User Interfaces for Illiterate and Semiliterate Users

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Abstract
We describe work toward the goal of a user interface (UI) designed such that even novice, illiterate users require absolutely no intervention from anyone at all to use. Our text-free UI is based on many hours of ethnographic design conducted in collaboration with a community of illiterate domestic laborers in three Bangalore slums. An ethnographic design process was used to understand what kind of application subjects would be interested in, how they respond to computing technology, and how they react to specific UI elements. We built two applications using these principles, one for job search for domestic laborers and another for a generic map that could be used for navigating a city. The resulting designs are based on key lessons that we gained through the design process. This article describes the design process, the design principles, which evolved out of the process, the final application designs, and results from initial user testing. Our results confirm previous work that emphasizes the need for semiabstracted graphics and voice feedback, but we additionally find that some aspects of design for illiterate users that have been previously overlooked (such as a consistent help feature). Results also show that the text-free designs are strongly preferred over standard text-based interfaces by the communities which we address and that they are potentially able to bring even complex computer functions within the reach of users who are unable to read.

Introduction

Most computer applications pose an accessibility barrier to those who are unable to read fluently. The heavy use of text on everything from menus to document content means that those who are illiterate or semiliterate are not able to access functions and services implemented on most computer software.

It does not have to be this way. In particular, while there might be limits to what static books can convey without text, computers are the ultimate multimedia device. Through the use of graphics, animation, and audio, they have the potential to be wholly intelligible to a person who cannot read (Huenerfauth, 2002).

The basic features of what we call a text-free user interface (UI) are simple to understand: liberal use of graphics and photographs for visual information, and voice for providing information normally provided via text. However, research to date on UIs for illiterate users remains scant, and existing work presents broad design guidelines that do not address all of the issues.

The work presented in this article was motivated by a single goal: to provide useful applications to communities of illiterate users, with a UI designed such that even novice, illiterate users required absolutely no in-

Figure 1. Site visit: at the houses of our target users.

tervention from anyone at all to use. In particular, we felt that if the UI were designed well, users would not require formal literacy, computer skills, or any external assistance in order to operate the application.

We certainly have not achieved this ambitious goal, but in the process of aiming for it, we have uncovered some of the subtler issues that require consideration when designing any text-free UI. We are also encouraged that the goal is not that far out of reach.

This article presents two applications that were designed using ethnographic or contextual design techniques to ferret out the requirements for a text-free UI. In the first, an employment-search application, the intent is to provide job information to a group of domestic laborers. In the second, we explore a text-free UI for maps that should allow illiterate users to answer questions having a geographic dimension.

Our approach is one of *contextual or ethnographic design* (Crabtree & Rodden, 2002; Wasson, 2002) in which intense interaction with a target community is sought to gain a thorough understanding of their real needs, real traits, and real responses to the interfaces we designed. Ultimately, we spent a total of more than 180 hours working with women in Bangalore slums to get feedback on our UI.

Section 2 of this article describes our target community and Section 3 gives an overview of the ethnographic design process. Section 4 describes a set of core design principles along with examples of many of the design details that we came upon during the iterative design process. Section 5 describes the final prototypes to which these principles were applied. These prototypes were then tested with subjects who were drawn from the same community but had not been exposed to the applications during the design process.

Target Community

We based our project in three urban slum communities in Bangalore, India. To gain access into these communities we worked with a nongovernmental organization called Stree Jagruti Samiti, which has had an established presence in these three slums for 15 years. Because Stree Jagruti Samiti works primarily with the women in the slums, we also focused on the needs of the women for one of our projects (Figure 1).

Most of the women in the slums are household workers, either illiterate or semiliterate (highest education attained being schooling up to the sixth grade). The male members of the house are usually daily wage laborers like plumbers, carpenters, construction workers, mechanics, bar benders, and fruit and vegetable vendors. Their primary language of communication is Kannada, which is also their native language. Apart from this a few people also spoke Hindi and Tamil. The average household income was INR 800–INR 3,000 (approximately USD 18–USD 67) per month. A few of them also had television sets, music players, and liquified petroleum gas burners. Some of them have seen computers in the houses of their employers, but were prohibited from touching the computer (even for the purposes of cleaning!). None of them had previous experience using a computer. During the time that we interacted with this community, we interacted with no fewer than 80 women and men, who ultimately saw the designs at some stage of their development.

Ethnographic UI Design

In designing the UI, we drew from guidelines of *ethnographic design,* in which techniques of ethnography were used to gain a deep understanding of the subjects, within the context of their specific goals (Cooper & Reimann, 2003). We held interviews and conducted subject trials with our target communities. We repeatedly went back to them to evaluate our designs and incorporated the necessary changes in the next prototype we designed. Being accepted and trusted by the community, making the subjects feel comfortable to talk and extracting relevant information from them (Parikh, Ghosh, & Chavan, 2003b), helping them overcome fear and reluctance while using technology (Chand, 2002) were a few of the challenges we faced during the process of design.

We had to take various actions to accommodate subjects and make them feel at ease. We spent considerable time in the community, attending weekend meetings to understand the context, culture, and practices (Parikh, Ghosh, & Chavan, 2003b). We visited the communities on an average of two to three times a week, for 3–4 hours each session, for several months.

We used this approach to determine the application domain in which to test our user interfaces. Our subjects—mostly domestic laborers—find job information through word of mouth or through agents within the slum that informally connected employers with employees. Most of the women often continued working at the same place for low wages because they were not aware of better opportunities elsewhere. We, therefore, decided first to mock-up a job-search application. Our focus group–style discussions of 40–50 women showed that the women were accustomed to asking the following information about a job: specific tasks requested by the employer, work schedule, break-up of wages by task, address of the employer, number of rooms in the residence, number of people residing, and location within the city.

To ensure that the design principles were not application specific, we also implemented a map application that was meant to provide geographic information. Maps were not common artifacts for the women we worked with, even though geography was a critical factor in the daily decisions they made; as a result, we felt it was a good testbed for text-free UI.

Design Principles

We arrived at a set of design principles as guidelines for text-free UIs as a result of the lessons learned from extensive field studies we conducted. We shall explain these with examples elucidating each principle in the following section:

Avoid Text (But Numbers Are Okay)

Clearly, less text makes sense for subjects who cannot read. However, as we discovered that subjects could easily recognize numerals ("0", "1", "2", "3", "4," . . .), these numerals can remain in the UI (at least for certain target users). This is consistent with advice in some earlier work (Parikh, 2002; Parikh, Ghosh, & Chavan, 2003a, 2003b).

Use Semiabstract Graphics and Increase Photorealism with Deeper Interaction

We knew that for both applications the information had to be in graphical form, since our target users were not generally literate (Huenerfauth, 2002; Parikh, Ghosh, & Chavan, 2003a, 2003b). While this is an obvious feature, the exact nature of the graphics can make a huge difference, and, below, we outline some of the more subtle findings from the ethnographic design process.

Frequent iterations with the target community are necessary to ensure that graphical elements are interpreted the way they are intended. We observed that subjects recognized semiabstract cartoons and more photorealistic graphics much better than complex abstract graphics. As users delve deeper into an object to get more information, the representation can become more photorealistic to provide more specific information.

In general, subjects were able to identify both photographs and pure cartoons, but there was a general preference for semiabstract cartoons. These cartoons were sketched by us and tested extensively in the field.

Too much abstraction could cause some difficulty. For example, in the map application, animated arrows for depicting one- or two-way traffic were not readily understood. When the arrows were replaced with small icons of cars, subjects immediately understood the meaning (Foltz & Davis, 2001). There was also a tendency to take some abstracted elements literally. Color of the graphical elements, for example, played a role in interpretation of map entities. For example initially we tried to depict roads in 80% black that on mouse hover become yellow. The idea was to highlight and separate the road as an individual entity. We received the feedback from the users that roads can never be yellow and they are

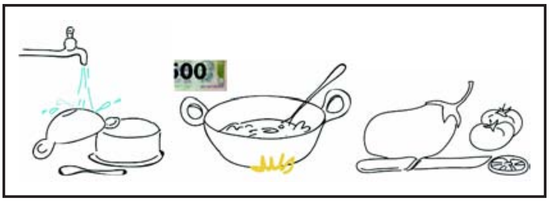

Figure 2. Unabstracted icons with action cues.

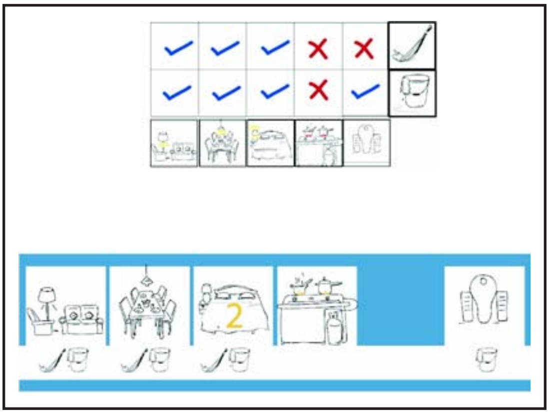

Figure 3. Indicators of which tasks were required in which rooms. The matrix structure (top) was not readily understood.

always black. Based on this feedback, we changed the color of the road to 100% black and on mouse hover 80% black.

In some cases, an abstract icon worked for a general instance (e.g., hospital) but was not sufficient for indicating a specific instance (e.g., Jayanagar Hospital). To resolve this problem, we used actual photos of specific landmarks to appear on mouse hover.

Pay Attention to Subtle Graphical Cues: User Response May Depend on Psychological, Cultural, or Religious Biases

The devil is in the details. For example, actions may require a visual representation, or they would be taken as static representations of location or object (Huenerfauth, 2002).

We found that they were better able to identify activities as actions when the cartoon included standard visual cues for indicating motion—water running in a faucet, steam puffing out from a kettle, and so forth (Figure 2). Without these action elements, subjects felt the drawings represented objects or locations (e.g., kitchen), rather than the associated action (e.g., cooking).

Figure 4. Ambiguity in iconic representation due to cultural biases: Our initial design indicating start and end times for a job places the start time at left (left). This is misinterpreted in Muslim culture. Adding an arrow avoids this problem (right).

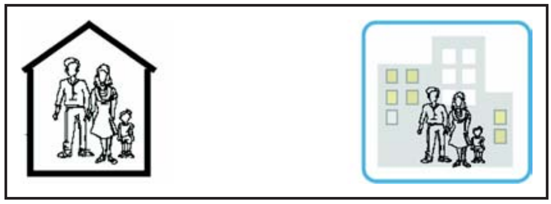

Figure 5. Designs for the "residence" icon. Our initial design (left) was perceived as a hut; the final design (right) is more in line with what our subjects interpreted as an urban residence.

We had used a matrix of checks and crosses to show what activities needed to take place in which rooms (Figure 3). These were not readily understood by our subjects, echoing results from other work that suggest graphical representations must be kept simple (Parikh, Ghosh, & Chavan, 2003b). We replaced them with explicit associations between room and task without the matrix structure. Sometimes differences in religion or culture caused different interpretations of graphical elements. For example, probably because Urdu is written from right to left, Muslim culture views time as flowing from right to left by default. Where we display work schedules, this required an explicit arrow between our start and end clocks faces, so that there was no misunderstanding (Figure 4).

Some of our initial icons were not interpreted the way we expected (Huenerfauth, 2002; Parikh, Ghosh, & Chavan, 2003b). For example, our initial graphic for a residence is shown in Figure 5 (left), what we thought was a universal symbol for a house. Our subjects, however, perceived it as a village hut and were confused, because they expected that prospective employers would live in a tall apartment complex; with their feedback, we redesigned this logo as shown in Figure 5 (right).

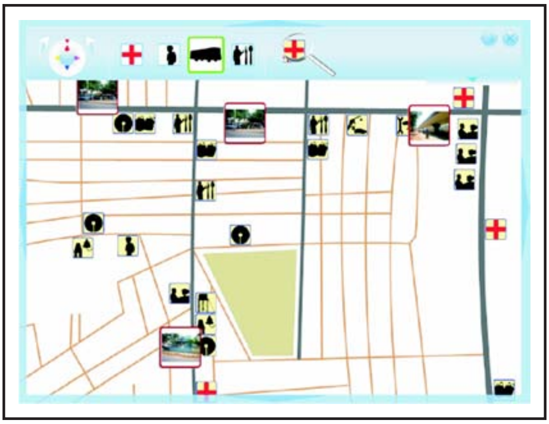

Figure 6. Map application with heavy use of landmarks.

Figure 7. Design of the "Introduction" page of the final prototype of the application.

Provide Voice Feedback for All Functional Units

The clear value of voice feedback is noted in previous work (Huenerfauth, 2002; Parikh, 2002; Parikh, Ghosh, & Chavan, 2003a, 2003b). It is important, however, that this guideline is zealously applied.

Provide "Help" on All Screens

The use of help instructions allows an application to be more autonomously used, even for novice users. Optionally, an on-screen character could be placed so that users can put a visual figure to voice playback.

Miscellaneous

Text-Free but Not Click-Free

As expected from novice users, the subjects did not have fluent control of the mouse and stylus and hesitated to click the mouse or press the stylus, as also mentioned in some previous work (Chand, 2002). At one point, we tried a click-free interface in which actions associated with clicking occurred after a 3-second mouse hover.

However, subjects were as confused by this as by experienced PC users (who typically find such behavior annoying). We therefore ultimately removed the click-free feature and kept click-free actions to be those which were either (a) associated with additional information (e.g., photo display or voice on mousing over an icon) or (b) immediately associated with moving the mouse onto an actionable icon (e.g., panning the map using the borders of the application). In the latter case, we found it useful to reserve clicking for advanced versions of the same action (e.g., accelerated panning).

Importance of Landmarks in Geographic Navigation

Throughout all of our queries about physical location, one abundant piece of feedback was that our subjects relied primarily on landmarks—and not absolute (north–south–east–west) direction or addresses and street names—for navigation. Thus, in our employment-search application, we restricted our attention to an almost purely landmark based interface; whereas in our map application, we explored additional map functions while keeping a landmark-based presentation (Figure 6).

Final Prototype

We put these design principles into use as thoroughly as possible in designing our two applications. The final prototypes are as follows (voiced help instructions for the employment application are in the appendix):

Employment Search

Introduction Page

The first page consists of an icon that represents job information for employees. This page is intentionally simple to avoid overwhelming first-time users (Figure 7). Even "decorative" text was removed so as not to

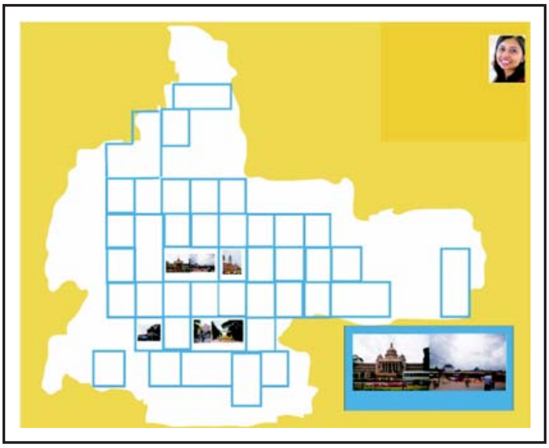

Figure 8. Design of the "Location" page of the final prototype of the application.

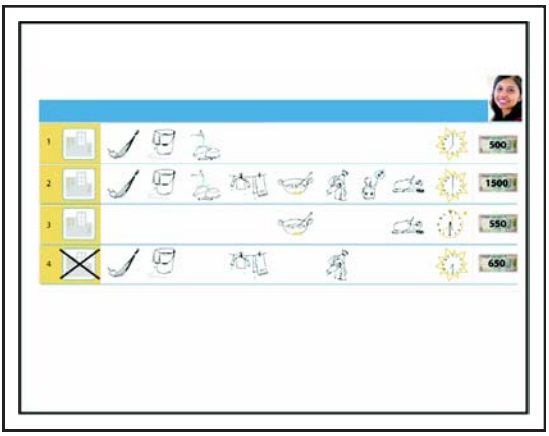

Figure 9. Design of the "Job Listing" page of the final prototype of the application.

intimidate illiterate users. On clicking this icon, one arrives at the "Location" page (Figure 8).

Location Page

The user can retrieve information about how many jobs are available in each area. On mousing over a landmark, the placename is called out, and the rectangular icons animate into an enlarged image of the landmark. A click on one of these rectangles on the map allows the user to navigate to the "Job Listing" page (Figure 9).

Job Listing Pages

In these pages, the jobs available in a neighborhood are listed along with the basic information about each job. In order to proceed to detailed job descriptions, the user must click anywhere within a particular row of information.

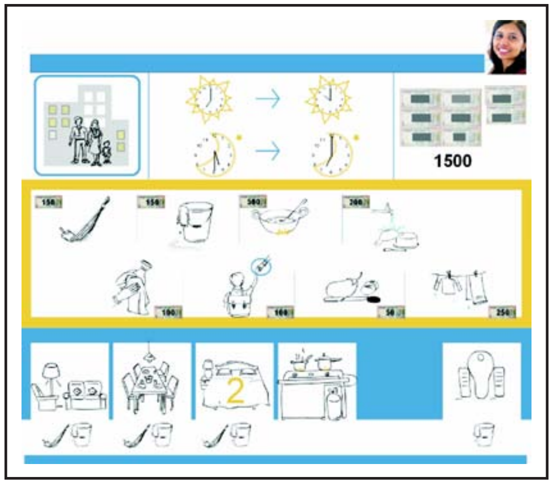

Figure 10. Design of the "Job Description" page of the final prototype of the application.

Job Description Page

This page compiles all of the relevant details about a particular job—address of the potential employer, wage break-ups, chores to be performed, number of rooms in the employer's house and the work timings with voice descriptions on mouseover. On every page, there is a "back" button to return to the previous page (Figure 10).

Map

The final prototype for map application consisted of one screen having all the major landmarks and roads. It allowed its users to pan, rotate, and zoom the map from any point (Figure 11). The additional features applied in this application are panning on mouse hover using a border of 16 pixels on all the four sides, rotation of map, visual filtering of landmarks, and virtual companion.

Experiments and Results

We performed preliminary subject testing with both applications to get a sense for the following questions, before proceeding with a large-scale study:

1. Can illiterate or semiliterate users use traditional text-based UIs at all?
2. Do the proposed design principles for text-free UIs allow illiterate users to use computers, and to what extent?

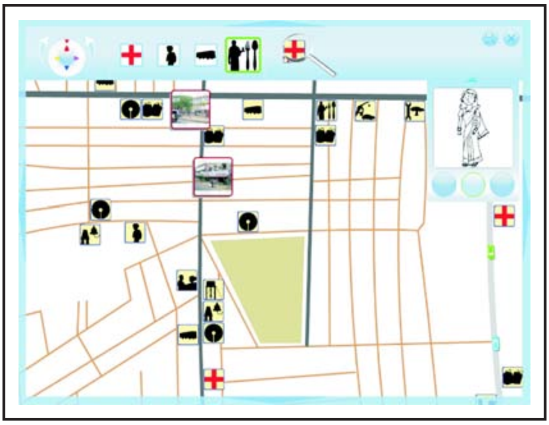

Figure 11. Design of the final prototype of the map application.

3. Which of the design principles make the most difference for a text-free UI?

The answer to the first question would seem an obvious "no," and our results verify this, but to the best of our knowledge this is the first time that this question has been formally tested. The other two questions are broader and the tests were intended to reveal the value of the proposed design principles.

Experimental Set-Up: Cultural Considerations

In traditional user studies, subjects are generally familiar with computers and live in economic conditions similar to their testers. Because of this, tests can be conducted in usability labs with controlled environments, and little attention needs to be paid to the mental comfort of the subjects. In our case, however, our subjects were not habitual users of PCs (hence, our terminology below will refer to them as "subjects" not "users"), and, more important, they were drawn from communities that often fear testing of any kind and find air-conditioned office environments alien and possibly intimidating. Thus, we needed to make a number of modifications to ensure that subjects were as comfortable in the environment and testing scenario as possible.

First, in all cases, we performed the testing in a physical setting that was routine for the participants. In most instances, we visited subjects in their own homes (in slum neighborhoods of Bangalore); in a few cases, we conducted tests in the homes of their employers. Second, for all of our participants, we reached out through contacts whom they trusted, and who were in almost all cases present through the duration of the study. Although this was less than ideal for thorough randomized testing, we could not find an easy way around the fact that most subjects would not feel at all comfortable undergoing technology tests with strangers. The critical aspect of the subjects—that they were illiterate or semiliterate—however, was preserved.

Third, while most (though not all) user studies tend to focus on isolated tasks, we found this was inadequate, as subjects had a poor understanding of the capacity of the computer overall, and almost no sense for what kind of tasks could be accomplished. We used a methodology termed the "Bollywood Method" (Shaffer, 2004), in which tasks are embedded in dramatized stories involving the subject, which has been found to be better at motivating subjects toward the desired tasks, even for computer novices. Particularly in an Indian context, where subjects tend to be reserved about giving feedback to people they perceive to be in authority—as test administrators were perceived to be—this was an invaluable tool for encouraging honest feedback.

Experimental Set-Up: Application

We tested both the employment-search and map applications with two interfaces: one that was text-based and another that was text-free. The text-based and text-free versions of both applications had the same content, so that we could isolate the differences due to interface design.

Employment Search

For this application, we actually tested three configurations, as follows:

- Text-based version: A standard text-based web interface, with routine structuring and indenting of data for ease of reading.
- Text-free version with help instructions: the text-free employment-search UI as described in the "Final Prototype" section.
- Text-free version without help instructions: the text-free employment-search UI as described in the "Final Prototype" section, but without the help feature.

Script

We first began with a (very) basic overview of computers and introduced the application to the user.

Once we were satisfied that they understood the capability of the application, we then told them the following story: A friend of theirs who lived in their neighborhood was in trouble and desperately looking for a job. Their objective was to find the best-paying job in a nearby neighborhood and to be able to report the address of the potential employer. (We initially started by asking them to find a job for themselves but switched to this scenario after one woman in one of our earlier trials seemed agitated by the idea that she would need to find herself a job.) This was broken down into two subtasks for testing purposes: (1) reach the point where they can identify their own neighborhood and (2) respond with the address of the highest-paying job in their neighborhood.

Map

In this we compared our text-free digital map UI with one commercially available text-based digital map of Bangalore.

Script

We took a commercially available text-based digital (MapCue Bangalore, 2001) and our text-free map of Bangalore to the users for final user testing. Unlike the more open methodology used in the user studies, here we defined three tasks for each of the users and embedded them into three stories. The goal was to test both maps in lifelike situations that may occur and to compare the degree to which subjects could complete the tasks. Each time, we presented one of the maps to the users first and asked them to accomplish the task on it. Once they completed the task (or had given up), we then presented the other map and had them try the same task on that map. Half of the subjects saw the text-based map first; the others, the text-free map.

Experimental Set-Up: Subjects

Our subjects were drawn from the same community as described in the "Target Community" Section. The subjects were illiterate and semiliterate (could write their names, read isolated words and do some basic addition) adults living in slums who had no previous exposure to computers. All have used pay phones and TVs. We chose a range of such participants varying in age, environment in which they lived and worked at present, and their familiarity and comfort with technology. The taxonomy with an example from our test participant of each of the categories is as follows:

1. Has never seen a computer: Newly migrated into the city from the village; has never seen a computer before.
2. Has only seen a computer rarely, but never one being used: Typical of part-time domestic helper who has seen a seen a computer at an employer's house but has never touched a computer, even to clean one.
3) Regularly sees people using a computer: Full-time house-keeping staff member at an office with PCs; has never used PCs; possibly came into contact while cleaning.

For the employment-search application, we tested four single participants and two collaborative groups of five women each. All subject sets were tested on all three versions of the application (text-based, text-free with help, and text-free without help), in randomized order. For the map application, three individuals were tested on both the text-based and text-free UI.

These numbers are admittedly small, and the quantitative results (presented in Appendix) do not achieve statistical significance. However, over the course of our design iterations, we interacted with more than 80 women and men of varying ages (the majority were adults, but some of the tests included children who were only 13 years old, but had adult work responsibilities) for a total of more than 180 hours spent with subjects, and, although most of this time was not spent in formal subject testing, these interactions provided a significant amount of informal data, which was consistent with what we found in our formal tests—if not quantitatively, at least qualitatively.

The two collaborative subject tests had two groups of five participants (with one person controlling the stylus) interact with the employment search application. We noted significant differences in individual and group tests which are discussed in the qualitative section of the results below.

Quantitative Results

Results are given in Tables 1 and 2. Our tests answered the first of our questions decisively. Overall, participants were totally unable to make any sense of the text-based user interfaces for either applica-

Table 1. Comparison of Results between Text-Based and Text-Free Employment-Search UI in Subject Testing

	Task 1: Find Neighborhood			Task 2: Get Address		
	Task Completed	**Prompts Required until Subjects Gave Up**	**Completion Time (min)**	**Task Completed**	**Prompts Required for Completion**	**Completion Time (min)**
			TEXT-BASED			
Subject 1	No	18	—	No	—	—
Subject 2	No	19	—	No	—	—
Subject 3	No	16	—	No	—	—
Subject 4	No	5	—	No	—	—
Average	0%	14.5	—	0%	—	—
Group 1	No	15	—	No	—	—
Group 2	No	17	—	No	—	—
Average	0%	16	—	0%	—	—
			TEXT-FREE WITHOUT HELP			
Subject 1	no	—	—	no	—	—
Subject 2	yes	11	21.0	no	—	—
Subject 3	yes	10	17.0	no		
Subject 4	no	—	—	no	—	—
Average	50%	12	19	0%		
Group 1	yes	7	12	yes	19	25
Group 2	yes	8	13.5	no	—	—
Average	100%	7.5	12.7	50%	19	25
			TEXT-FREE WITH HELP			
Subject 1	yes	5	14.0	yes	11	28.0
Subject 2	yes	3	12.8	yes	7	25.0
Subject 3	yes	2	11.0	yes	6	23.5
Subject 4	no	8	—	no	—	—
Average	75%	4.5	12.6	75%	8	25.5
Group 1	yes	1	5.0	yes	3	12
Group 2	yes	2	6.0	yes	5	13.5
Average	100%	1.5	5.5	100%	4	12.7

tion. None of the seven individual subjects nor any of the subjects tested in groups were able to navigate the text-based UIs, even with prompting and encouragement. Most of the subjects were simply unable to read the text at all, and even those who could read isolated words were not able to read fluently enough to put what was written into the context of the scenario. For the map application, none of the participants were even able to locate the important landmarks for any of the tasks in the text-based map. Moreover, without the voice feedback, even users who had seen the text-free UI first did not realize without significant prompting that one could click on text to cause an action (and with prompting, they still did not understand what they were clicking on).

Table 2. Comparison of Results between Text-Based and Text-Free Map UI in Subject Testing

	Prompts		Completed		Time taken (in min)	
	Text-Free	**Text-Based**	**Text-Free**	**Text-Based**	**Text-Free**	**Text-Based**
	Task 1: Find all the Hospitals in the Vicinity and Then Look for a Cardiac Care Hospital					
Subject 1	7	24	yes	no	9.0	19.5
Subject 2	5	20	yes	no	12.0	20.0
Subject 3	7	27	yes	no	10.5	25.0
Average	6.3	23.6	100%	0%	10.5	21.3
	Task 2: Locate Your Position, Find the Nearest Bus Stop, and Direction of Traffic on Roads					
Subject 1	8	25	yes	no	11.0	23.0
Subject 2	7	25	yes	no	11.5	25.0
Subject 3	7	24	yes	no	14.5	21.5
Average	7.3	24.6	100%	0%	12.2	23.2
	Task 3: Recall the Map Interface and Describe Its Behavior without Seeing It					
Subject 1	11	27	partially	no	17.0	19.5
Subject 2	10	23	partially	no	12.0	15.0
Subject 3	15	25	partially	no	18.0	18.0
Average	12	25	NA	0%	15.7	17.5

Qualitative Results

Throughout our design iterations and formal subject studies, we made a number of informal qualitative observations, which we have so far not followed up with quantitative tests. Many of these were rolled back into later redesigns. The others we offer here as possible hypotheses for future verification or for application to future work with text-free UIs.

Immediate Comprehension of Voice Feedback

With almost no exception, we found the same reaction to those who were exposed for the first time to voice feedback in their own language: Most were thrilled to hear a computer speak in their native language and went as far as to call others in the vicinity to hear for themselves. In fact, voice feedback appeared to make the applications *fun* for subjects, who seemed more engaged and eager to explore the application.

During our trials, there were a few cases when subjects had heard from previous subjects that there were both text-based and text-free versions of each application. If they were given the text-based UI first, they would frequently ask for the text-free version, on which they felt they could perform better.

Collaborative Use

At one point when we were conducting subject studies, a group of women began playing with the application between our formal test sessions. As they seemed more animated, we allowed them to continue for some time. In our individual tests, subjects appeared nervous and uncomfortable, probably because they were being videotaped and scrutinized in isolation in front of researchers. The group, on the other hand, seemed more confident, suggesting ideas to one another, discussing the purpose of the application, advising each other, and interacting more boldly with the computer. Their faces beamed and their voices were louder compared with single-subject tests. This prompted us to do the collaborative studies cited above, but we feel there is the potential for future design taking into account a collaborative user model, as well.

The Value of Help

In addition to the fact that the help feature shortened the time that tasks were completed in the employment search application, they were also found to be a constant source of reassurance to users. There were occasions when before performing a task on a particular page they referred to help three or four times. As with voice feedback, the help feature made them eager to explore the text-free UI, whereas without help the response was more subdued; participants did not seem as interested in exploring. In one of the sessions, we observed that subjects went to the help icon themselves without any prompting and performed the actions exactly as told by the help. The same pattern continued for forthcoming screens, and before taking any further action they referred to help.

This was brought out in our map application, which, although it provided functional help for each icon, offered no overall help feature. Throughout the study, we found that we needed to prompt and encourage subjects to try out things on screen. It is possible that a few encouraging voice instructions telling users how to operate the tool would be helpful.

Navigation Metaphor

In our employment-search application, we felt that subjects were quicker to understand hypertext navigation when they were told to think of the pages as pages in a book. Although no quantitative studies were performed, the most recent version of the help recordings that made this analogy seemed to help more than earlier versions that did not.

No Faith in Technology

For at least two of our subjects, it took a significant effort to explain to them that a computer could provide them with the information they were asked to find in their scenarios. One test subject, in particular, was ultimately not convinced about a computer's ability to deliver job-related information and was apathetic to the point that she refused to continue with the study.

Subject Involvement Among Test Subjects

One thing we found repeatedly among our more comfortable subjects was that they were eager to give us advice about design and potential features (Parikh, Ghosh, & Chavan, 2003a, 2003b).

Related Work

The existing body of research that investigates user interfaces for illiterate users work is recent and few research groups have looked at designing for this population. Early researchers in this area place emphasis on the need for contextual design methods to explore this problem, as illiterate users are very different from the target user imagined by most UI designers (Cooper & Reimann, 2003). We follow this lead, and have spent literally hundreds of hours in the field, working with illiterate women. Most previous work with illiterate users suggests the use of graphical information. In particular, researchers immediately intuited the value of imagery in place of text, and extensive use of graphics is advocated by most of this work (Griesdale, Graves, & Grunsteidl, 1997; Huenerfauth 2002; Parikh, Ghosh, & Chavan, 2003a, 2003b; Medhi & Kuriyan, 2007; Medhi, Pitti, & Toyama, 2005; Medhi, Prasad, & Toyama, 2007).

Some research groups have also investigated the value of voice annotations and instructions, which are of obvious value to illiterate users (Parikh 2002; Medhi & Kuriyan, 2007; Medhi, Pitti, & Toyama, 2005; Medhi, Prasad, & Toyama, 2007). Separately there is a body of research that looks at the use of voice auditory interfaces for information communication. However most of this work does not specifically target illiterate populations. In this stream there are research papers that have demonstrated the utility of auditory icons in addition to standard graphical feedback in communicating information to users (Blattner, Sumikawa, & Greenberg, 1989; Gaver, 1989). This confirms our finding that graphical icons with voice annotation generally help users in speed of comprehension. Existing literature also suggests that auditory icons are an intuitively accessible way to use sound to provide multidimensional, organized information to users (Gaver, 1989a, 1989b).

Some authors researching illiterate populations note the plausible inclusion of number, as illiterate users are often numerate (Medhi, Pitti, & Toyama, 2005; Parikh, 2002; Parikh, Ghosh, & Chavan, 2003a, 2003b). Others focus on the need for ultra-simplified navigability as a design element (Griesdale, Graves, & Grunsteidl, 1997).

Our work builds on many of these findings of this previous work but also evolves the ideas further, particularly in approach, design elements, and final implementation. Because this is a relatively new area of research for user-interface designers, interaction with the target user groups is essential. Using contextual design methods similar to that used by the research in rural microfinance (Parikh, Ghosh, &

Chavan, 2003b), we also spent a considerable amount of time with our subjects. For each of our applications, we went through at least eight iterations each of redesign and subject feedback. (Here we are counting instances when there were fundamental changes in the UI; there were many additional separate occasions when small groups were consulted for minor changes.)

This close interaction leads to some subtle and not-so-subtle differences in design elements. The subtle elements tend to be specific to the application domain and the target subjects. Previous work, for example, does not cite action cues in graphics to indicate actions, but this may not arise in applications where icons only represent static objects. Our reliance on landmarks in maps is also something we chose when subjects were repeatedly unable to comprehend standard map representations. A significant requirement that previous work does not mention is the need for abundant and consistently available help instructions. As we found ourselves repeating the same background material and instructions to our subjects each time we visited them, we thought that this material could be encapsulated into the application itself, and this addition had a profound impact on the subjects' sense of autonomy.

Finally, while all previous work suggests design elements, none mention the importance that these elements must be applied thoroughly across the application. Even a single icon missing voice annotation, for example, causes confusion, as subjects expect to be able to point to any graphical component and find out what it represents. Similarly, help, if it is made available, must be available all the time, or it will cause a loss in confidence among subjects who tend to blame themselves for the interface's shortcomings.

Conclusion and Future Work

In this article, we have presented two text-free user interfaces applied to the particular applications of providing information about employment opportunities for domestic laborers and a digital map designed for illiterate and semiliterate subjects. Through an extensive ethnographic design process involving more than 180 hours with 80 women and men from three Bangalore slum communities, we discovered several design elements that were incorporated into the final design, that we believe could be applicable to other user groups that are illiterate and new to computer use. These include obvious and previously cited features such as graphical icons, voice feedback on all functional units, minimal use of text, and active visual response on mouseover, but also thus far unnoted features such as semiabstracted, instead of purely iconic graphics, and consistent help for all application "pages." Results also showed that the text-free designs were strongly preferred over standard text-based interfaces by the communities we addressed.

Toward the end of our work, for example, we discovered that some users fundamentally doubted the ability of a cold piece of technology to deliver the information they were interested in. We observed that in spite of our subjects' understanding of the UI mechanics, they experienced barriers beyond illiteracy in interacting with the computer: lack of awareness of what the PC could deliver, fear and mistrust of the technology, and lack of comprehension about how information relevant to them was embedded in the PC. We addressed these challenges with full-context video, which includes dramatizations of how a user might use the application and how relevant information comes to be contained in the computer, in addition to a tutorial of the UI (Medhi & Toyama, 2007).

Separately we also conducted research toward an understanding of the optimal audio-visual representation for illustrating concepts for illiterate and semiliterate users of computers by comparing different representational types in a way that fairly stacked one representational type against the others (Medhi, Prasad, & Toyama, 2007). While we are not yet at a point where we have achieved the goal of a truly assistance-less user interface for novice, illiterate user, we believe this work takes us one step closer. ■

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Appendix

The help instructions provided in the final prototype of employment search application in section 5 were as follows:

Instruction 1: Are you looking for a well paying domestic help job in Bangalore and do not know where to get job information from? This computer application will help you find one. Now, how do you interact with this computer/computer application?

This application is like a book and you can go from page to page. . . . I'll tell you how, now. . . . Hold the object which you have, like a pen. Do you see the big icon/picture at the center of the screen? Hold the head of the pen a very little away from the computer. You will hear the sound saying "Job information." To know more about where all you can get jobs, press the head of the pen on the picture with a little pressure.

And always remember, if you get lost or need help using this page, hold the pen over my picture.

Instruction 2: This is the map of Bangalore and here you can find your favorite job based on location.

Do you see the little pictures on the map? Each of them represents a particular locality.

To know which locality it is, hold the head of the pen a very little way from the computer. You will hear the sound saying the name of the place. To know more about what all jobs are available in that particular locality, press the head of the pen on the picture with a little pressure and you will move to the next page.

And always remember, if you get lost or need help using this page, hold the pen over my picture.

Instruction 3: This shows you the jobs that are available in this locality at present.

Each row of pictures shows the kind of work you will have to do in each house.

Hold the head of the pen a very little away from the computer. After hearing sound, press the head of the pen on the picture with a little pressure to move into the next page and know the details of this particular job.

If you want to choose a different locality at any point of time, click on the blue bar on the top of the page.

And always remember, if you get lost or need help using this page, hold the pen over my picture.

Instruction 4: This page represents the particular job in which you showed interest just now.

This page gives you information about your potential employer's address, the time you will need to get to work, the wage you will get paid, the chores you will have to perform and also in which rooms you would have to perform them.

Do you see the little pictures on the page? Each of them will play a sound explaining the picture when you hold the head of the pen a very little way from the computer.

Remember that if you do not like this particular job, you can move on to the previous page, where the other jobs are listed. You can do that by pressing the pen head on the blue bar at the top of the page.

And always remember, if you get lost or need help using this page, hold the pen over my picture.

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Research Article

Speech Interfaces for Equitable Access to Information Technology

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Abstract
Speech recognition has often been suggested as a key to universal information access, as the speech modality is a "natural" way to interact, does not require literacy, and relies on existing telephony infrastructure. However, success stories of speech interfaces in developing regions are few and far between. The challenges of literacy, dialectal variation, and the prohibitive expense of creating the necessary linguistic resources are intractable using traditional techniques. We present our findings evaluating a low-cost, scalable speech-driven application designed and deployed in a community center in rural Tamil Nadu, India, to disseminate agricultural information to village farmers.

Introduction

Speech interfaces, or spoken dialog systems (SDS), allow users to control computer output (graphics, texts, or audio) by uttering key words or phrases that are interpreted using automatic speech recognition (ASR). Successful speech interfaces can accommodate the sight- or mobility-impaired by replacing or enhancing access to the computer output (screen) and input (keyboard, mouse) (Raman, 1997). Automated telephony systems are commercially available and are commonly used by businesses to reduce call center costs, as they are relatively affordable to run, once built. The main hurdle in replicating this success for the access of computing technologies in the developing world so far has been the prohibitive cost of computing devices, IT infrastructure, and designs for software and hardware that assume literacy and computer savvy (Brewer et al., 2006). Cell phones are affordable, the infrastructure they require is more readily available, and they are used extensively throughout the developing world. Often cell phones are shared by multiple users of varying degrees of literacy (Donner, 2004). Automated telephony services and other speech interfaces are attractive channels for information access especially among the oral communities in developing regions. For example, many applications for rural Indian IT that provide information on health, weather, employment, news, and agricultural could enhance the social and economic development of the rural poor (Sustainable Access in Rural India [SARI], 2005) and could be constructed around a limited-vocabulary speech interface. Others who have studied the positive impacts of speech-driven interfaces in developed regions, however, predict that such applications will likely not enhance the quality of life of those that rely on them (Jelinek, 1996).

To design a successful speech interface for use in rural India is to face considerable challenges. The ASR must perform in noisy environments where multilingualism and substantial dialectal variation are prevalent. The ASR must accurately recognize speech from languages for which neither annotated corpora nor other costly linguistic resources exist. The front-end dialog interface should be interactive, easily adoptable, and accommodate individuals who lack formal education and computer literacy. The user interface (UI) will be effective only if it stems from a deep understanding of a community culture and value systems. However, design techniques developed for accessing sociocultural models in relatively wealthy European and North American communities are ineffective in poor communities, where leisure and formal education are spare. Finally, a successful speech interface is one that supports an application based on local content created by local providers, as the information needs of rural communities include news, events, and innovations happening within a radius of only a few kilometers.

A speech driven application for developing communities must address all of these issues in order to successfully extend IT access to the developing world. This article offers design requirements and solutions for the local content creation, ASR, and UI for speech interfaces in developing regions. We evaluate our solutions through a participatory design and deployment effort in which we collaborated with community partners to provide interactive agricultural information to rural villagers in southern India.

SDS Content

Relevant, local content is a large concern for developing regions (Chisenga, 1999). Attempts by local or national government or nongovernmental organizations to provide free, locally available health, job training, and education services that meet the basic needs of the public often do not reach unschooled populations in an accessible, reliable form. Radio and TV are affordable forms of mass media that can be effective at creating initial public awareness. However, they are much less effective in influencing people to improve their practices in health, agriculture, or education than traditional, oral methods of information dissemination that stem from within a community (Soola, 1988).

Historically, society has seldom given poor people ownership over the tools of production (Castells, 1997; Gordo, 2003). However, researchers in the field of IT for developing regions agree that involving community members in design and creation ensures that proposed solutions meet the needs of the community and provide the best chance for the sustainability of technology in a community (Braund & Schwittay, 2006). IT offers the opportunity and infrastructure for publishing and distributing all types of information in the shortest possible time and at the lowest cost. In particular, IT can be used by community partners to provide accurate, locally created information to unschooled adults in developing regions.

Information Needs

In rural Tamil Nadu, 37.47% of full-time workers and 71.64% of marginal workers work in the agricultural sector—a majority of them small cultivators or seasonal laborers (Figure 1). Across all developing regions of the world, farmers and other agricultural workers constitute over 40% of the labor force. The information needs of farmers in developing regions are likely to be vast and varied. Although the ability and inclination to base sale decisions on price information is open to question (Hornik, 1988; Blattman, Roman, & Jensen, 2003), studies have suggested that under the right circumstances, price and market information can improve farmer welfare (Eggleston, Jensen, & Zeckhauser, 2002; Prahalad & Hammond, 2002). Information on recommended techniques (pest and disease prevention, new seeds) improve production (Blattman, Roman & Jensen, 2003) and IT-based information networks can help raise the price of goods sold for small farmers (Kumar, 2004).

MS Swaminathan Research Foundation

MS Swaminathan Research Foundation (MSSRF) is an established nongovernmental organization (NGO) in Tamil Nadu dedicated to a pro-nature, pro-poor,

Figure 1. Rural farmers in the Povalamkottai village plaza, Tamil Nadu.

Figure 2. MS Swaminathan Research Foundation village centers.

and pro-women approach to fostering economic growth in rural, agricultural areas. Gathering and distributing accurate information for unschooled agricultural workers is central to MSSRF's efforts.

Trained community members in villages across southern India operate MSSRF village knowledge centers (VKCs), where they provide the rural poor with training and education on agricultural practices, health, social issues, and entrepreneurial development. The trained volunteers from each community, known as "knowledge workers," regularly communicate the needs of their neighbors to village resource centers (VRCs) through weekly meetings, a user registry, and door-to-door surveys. The VRCs, in turn, communicate needs to MSSRF headquarters (Chennai, Tamil Nadu), where information content (text, audio, video), additional training, video conferencing, and workshops are provided to address the needs of communities across the state. Our project was conducted in collaboration with Sempatti VRC, which is responsible for 9 VKCs in the region (Figure 2), each one serving between 2,000 and 11,000 people.

In addition to bridging knowledge between communities and MSSRF headquarters, the agricultural experts at VRCs meticulously document the crops grown in the region, including varieties, planting techniques, soil properties and fertilizers. VRCs function as regional libraries for the rural illiterate person, as they contain a wealth of short videos prepared locally by universities and community organizations on recommended agricultural and health practices. In addition, video conferences conducted between VRCs allow farmer groups or self-help groups to communicate experiences and local innovations across districts of Tamil Nadu using traditional, oral techniques.

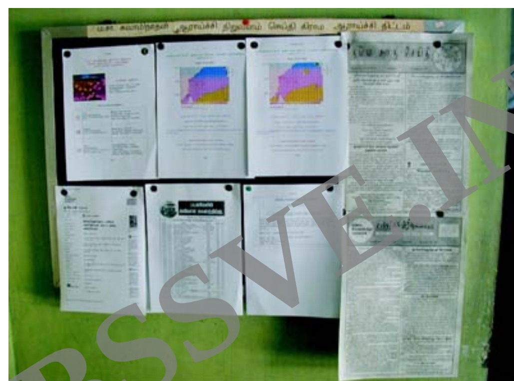

Figure 3. Daily postings of weather, news, and market prices at the Sempatti VRC.

Information from VKCs, VRCs, and headquarters is consolidated, digitized, and disseminated throughout MSSRF centers by phone, dial-up voice transfer, or wi-fi. Villagers may access accurate, up-to-date information at a nearby VKC by reading posted bulletins (Figure 3), listening to loudspeaker broadcasts, or working one-on-one with a knowledge worker (Balaji, et al., 2004). Knowledge workers often refer to a static, text-based HTML page called *Valam* (a

Figure 4. Valam ("Resources") Website available in all MSSRF centers.

Tamil word meaning *resources*) to retrieve locally relevant information on health, education, jobs, microcredit, self-help groups, and agriculture (Figure 4).

MSSRF staff in all three districts we visited reported a need to disseminate information in a form accessible to their predominantly oral population. In Sempatti, knowledge workers reported much success in educating illiterate people using a touch-screen kiosk, called the Livestock Guru (Heffernan, 2006). A major limitation to the tool, however, was its inability to be modified and updated. Throughout the design and evaluation of our technology, we relied on the experience of MSSRF staff in spreading relevant information across rural communities and adopted their belief that each village center is both a destination and a source for rich knowledge and information. Finally, the success of our project owes much to MSSRF's trusted role in the rural communities in which we designed and evaluated our technology.

ASR

ASR is the process of algorithmically converting a speech signal (audio) into a sequence of words (text). Although vendors of commercial systems and speech researchers often report the ability to correctly identify words from speech around 95% of the time, these numbers correspond to performance under optimal conditions (quiet, controlled environment, limited domain, single speaker). However, ASR is a nontrivial task because of the infinite variations of speech and will fail miserably in more challenging conditions (cocktail party, overlapping speech, etc.). State-of-the-art speech recognizers perform at only 80% on the Switchboard corpus, for example, a collection of near-natural, continuous speech recorded from multiple speakers during human-to-human telephone conversations. ASR decodes words from an audio signal by training hidden Markov models (HMMs) for phones, diphones, or triphones based on training data, generally a large corpus of speech that is hand-labeled at the phoneme or word level (Figure 5). ASR success depends on the collection and annotation of this training data, as well as the creation of a dictionary of all possible words in the language with all possible pronunciations for each word. A large vocabulary ASR also relies on language-level constraints captured by a language model either trained on a large text corpus or grammar rules meticulously created by a linguist. The creation of these linguistic resources (training data—speech, text and pronunciation dictionary) is arguably the most costly process of ASR development.

The availability of linguistic resources is taken for granted by developers who work in English, French, and Japanese, for example. The majority of the world's 6,000 languages, which are spoken in developing regions, currently have no associated linguistic resources. In India, there are two official languages (Hindi and English), 22 scheduled languages (including Tamil), and an estimated 400 more (Ethnologue 2006). The prohibitive cost of creating linguistic resources hinders the development of speech technologies for languages like Tamil, which is spoken by more than 60 million people in Tamil Nadu, Sri Lanka, and elsewhere (Ethnologue 2006). Equitable access to IT requires support for all languages, re-

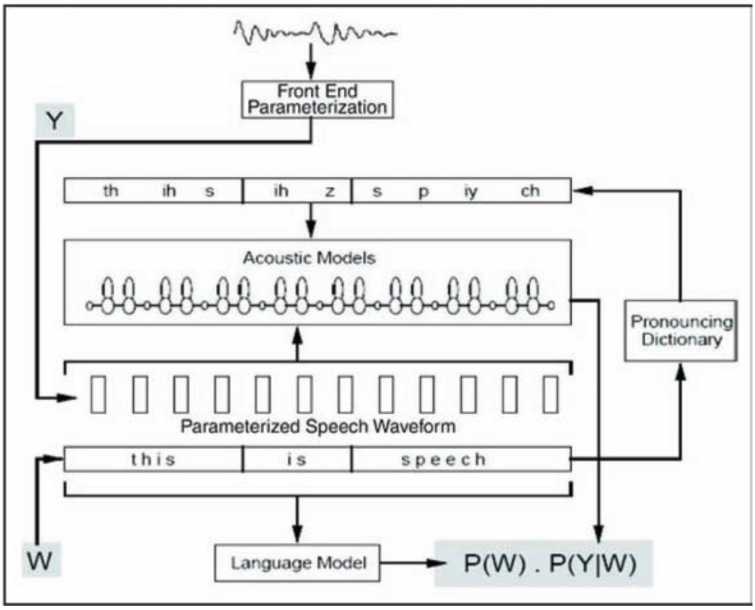

Figure 5. This diagram from Young (1996) shows the computation of the probability P(W|Y) of word sequence W given the parameterized acoustic signal Y. The prior probability P(W) is determined directly from a language model. The likelihood of the acoustic data P(Y|W) is computed using a composite hidden Markov model representing W constructed from simple HMM phone models joined in sequence according to word pronunciations stored in a dictionary.

gardless of their political dominance or number of speakers.

Researchers and developers of ASR strive for performance that mimics a human's capacity to understand speech (e.g., speaker-independent, large-vocabulary, continuous speech recognition). As a result, of the three basic principles to speech recognition performance (Table 1), the first principle, "The more data, the better," has dominated the direction of ASR research in languages with plentiful linguistic resources. One estimate, however, puts the amount of training data needed for current systems to achieve human levels of recognition between 3 and 10 million hours of acoustic training data, that is between 4 and 70 human lifetimes of exposure to speech (Moore 2003). The singular drive for more training data requires substantial cost, time, and expertise to collect and is ill suited to ASR in developing regions. In this article, we show how simplifying the recognition task and adopting adaptation techniques that tune the recognizer's models to match input data can achieve equivalent performance to better accommodate the economic and linguistic conditions of developing regions.

Field Study 1: Speech Collection for ASR

Speech recordings of rural villagers in three districts of Tamil Nadu were conducted in 2004 and 2005 to create adequate training data for machine recognition of a small vocabulary (less than 100 words) of isolated Tamil words. In the following sections, we evaluate the performance of a small Tamil word recognizer in the face of dialectal variation and limited training data. We focus on a recognition task that is relatively simple, yet adequate to power an SDS. In addition, we discuss the challenges of collecting speech data from unschooled adults and discuss alternative avenues for the creation of effective ASR models in regions such as Tamil Nadu.

Speech Recordings

During two field visits, we recorded the speech of 77 volunteers in three separate districts in Tamil Nadu, India (Figure 6). All volunteers were native speakers of Tamil over the age of 18. The researchers sought a balance of gender, education level, and age among participants, but the demographics of this study varied greatly by site (Table 2) and by recruiting method.

Coimbatore volunteers were either undergraduate students at Amrita University or laborers recruited by word of mouth; this method proved to be unsuccessful for the latter group. In Pondicherry, literate farmers and their wives were recruited as volunteers by MSSRF. In Madurai district, volunteers were recruited through MSSRF and Aravind eye

Table 1. Basic Principles of Speech Recognition Performance

The more data, the better.
The more input matches training data, the better.
The simpler the task, the better.

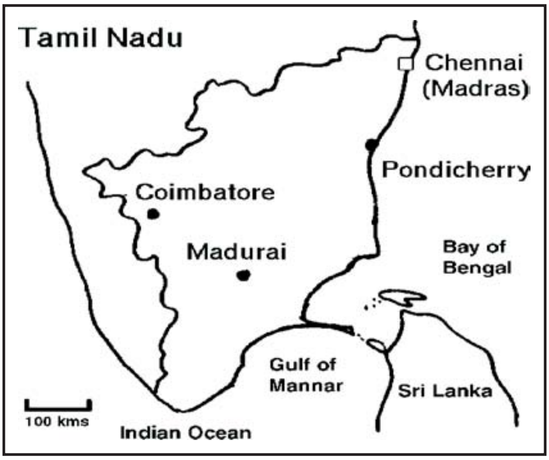

Figure 6. Map of Tamil Nadu, India.

Figure 7. Recording a literate woman in Ettimadai, Coimbatore district.

camps, where free eye care is provided in rural villages to between 200 and 500 people a day. We found that working alongside trusted organizations that serve the rural poor was the most efficient method for recruiting and recording villagers, especially those with little or no formal education.

Traditional data collection for small vocabulary speech databases relies on read speech in a quiet, controlled setting. Recordings for this study were conducted in the quietest available space, which, in many cases, was outdoors or in other public areas. Equipment and elicitation techniques varied by site; researchers had to be flexible to environmental conditions. Initially, literate Tamil speakers in Pondicherry (2004) were recorded saying 30 Tamil command words (e.g., "repeat," "send," "next") in relatively quiet offices with a lapel microphone or desktop microphone and a laptop running mouse-driven software that displayed a written word and recorded the speaker saying the target word.

Data collection in rural Tamil Nadu in 2005 relied instead on flashcards and a telephone handset with an embedded microphone connected to a Sony MD Walkman (MZ-NH900) (Figure 7). This allowed the speaker to comfortably hold the microphone close to the mouth but slightly to the side of the lips, to avoid "p-pops," bursts of high airflow during speech. In addition to capturing quality speech recordings in a variety of environmental conditions (average signal-to-noise ratio was 29), the modified telephone handset did not require us to clip or fasten equipment to the speaker's clothing and did not require the use of a table.

Bilingual flashcards with digits 0–10 written in both numerical and orthographic form were randomized and shown to speakers one at a time. Speakers were recorded reading the numbers aloud. The protocol was repeated five times per speaker. If a participant could not read the flashcards, a researcher or interpreter would translate the flashcards

Table 2. Number, Age, Gender, and Literacy of Speakers by Site.

Site (Year)	Number of Speakers	Average Age of Females	Average Age of Males	% Nonliterate
Coimbatore (2005)	15	20.7	31.4	13
Madurai (2005)	33	49.3	55.7	39
Pondicherry (2005)	7	37.5	47.3	0
Pondicherry (2004)	22	n/a	n/a	0
All Data	77	35.8	44.8	19.50

Here, "nonliterate" refers to speakers who could not read the flashcards and reported an inability to read or write their name. "n/a" signifies that speaker information is not available.

Figure 8. Recording an illiterate woman in Ettimadai, Coimbatore district.

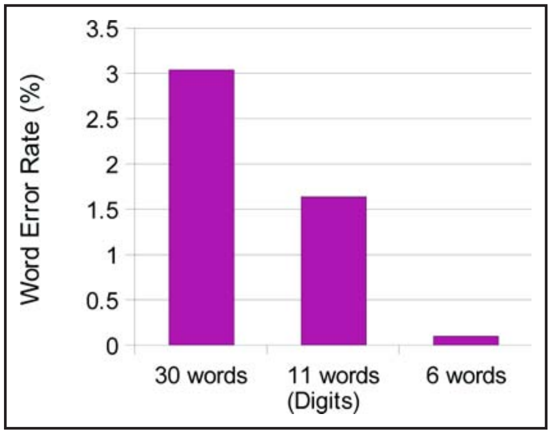

Figure 9. Word error rate by task complexity.

into a display of fingers (Figure 8). (A fist represented zero.) The flexible protocol provided a direct method for evaluating competency at literacy and numerical literacy. Both the flashcards and finger-counting methods were designed to elicit single word utterances free from external influences in word choice or pronunciation. All participants also answered a questionnaire to determine linguistic and educational background with the aid of a local interpreter.

Recording illiterate speakers saying the words for digits 0–10 took approximately six times as long as recording the same data from literate speakers. This discrepancy was due to difficulties explaining the task, limitations in the protocol (no reading aloud), inflexible and demanding occupations of participants, and apprehension involving participation, resulting in many missed appointments. In addition, illiterate speakers in this study had limited access to infrastructure appropriate for recording (no housing, no power, public buildings) and longer social protocols for foreign visitors.

Tamil Word Recognizer

All speech collected in Tamil Nadu was recorded at 44 kHz, stereo, then downsampled to 16 kHz, mono. Each of the approximately 10,000 speech samples were extracted with a collar of 100 ms of silence and labeled by hand in the laboratory. A whole-word recognizer was trained on the speech from 22 speakers in Pondicherry (2004) using the Hidden Markov Toolkit (HTK). The models used 18 states with 6 diagonal gaussians per state. Whole word models were used to avoid the need for a pronunciation dictionary. The following section describes various experiments to show how ASR accuracy depends on task complexity or vocabulary, dialectal variations, and amount of training data.

Experiment 1: Task Complexity

The speech collected from our field recordings was input for recognition in three trials of varying complexity: all words, digits only, and six command words. As expected, word error rates dropped for tasks with fewer options for correct word identity (Figure 9). An SDS with a small vocabulary of command words, or one that limits word options at each node of the dialog turn would require very little training data (less than 3 hours) to achieve accurate recognition.

Experiment 2: Dialectal Variation

Multilingualism, dialectal, and accent variations are prevalent in developing regions. India has 22 “scheduled” (official) languages but estimates range from 450 (SIL, 2005) to 850 languages (Noronha, 2002) overall. India is the ninth most linguistically diverse country, with a 93% probability that any two people of the country selected at random will have different mother tongues (Ethnologue, 2006). The Tamil language, like most languages, varies by geography (six main dialects), social factors (caste, education), and register (spoken vs. written). Recording the words for digits in three different districts of Tamil Nadu revealed that the pronunciation of the consonant in the Tamil word for “seven” and the choice of word for “zero” varied significantly ($p < 0.01$, $N = 385$; $p < 0.01$, $N = 379$) by geography.

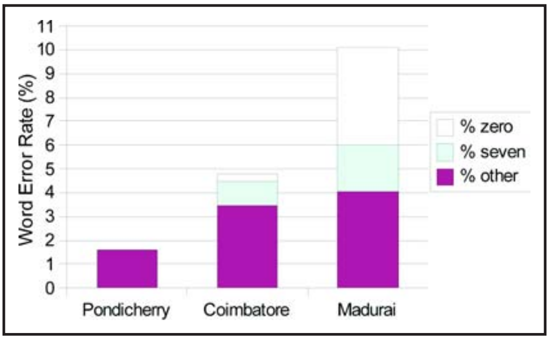

Figure 10. Word error rate for digits by site. Errors for the words "zero" and "seven" are explicitly indicated. The recognizer was trained on data from Pondicherry (2004) speakers.

Age, gender, and education level were not predictive factors in the phonetic and lexical variations.

To evaluate the influence of phonetic and lexical variations on a small vocabulary recognizer, we again trained the recognizer on the speech of the 22 Pondicherry (2004) speakers. Then, we tested the recognizer's performance on speakers from all three districts in our study (Figure 10). Digits spoken by Pondicherry (2005) speakers were recognized at less than 2% error. Coimbatore and Madurai speakers caused significantly higher word error rates ($p < 0.01$, $N = 3{,}168$). These results clearly show that a spoken dialog system should be trained on speech collected from people who are potential users of the fielded system to ensure there are no huge variations in dialect and choice of vocabulary between training speech and the field data.

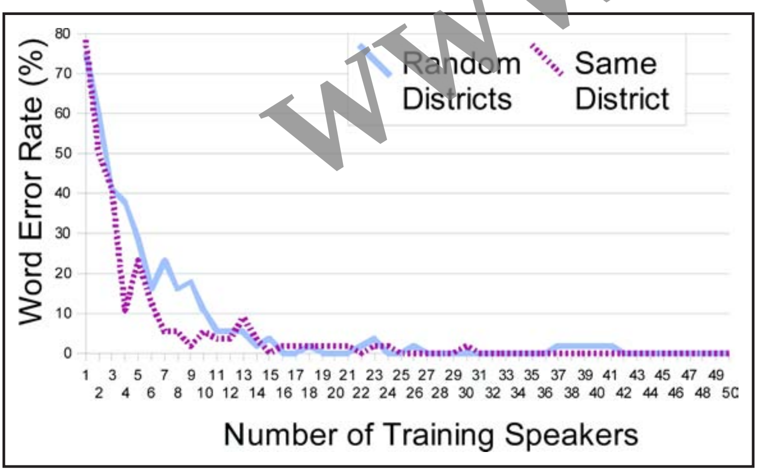

Figure 11. Word error rate by amount of training data.

Experiment 3: Available Training Data

Recognition performance depends largely on the quantity of available training data. Given that linguistic resources are limited in developing regions and that data collection is challenging and labor intensive, we ran simulations to determine the least amount of data needed to achieve acceptable error rates for the operation of an SDS.

For each simulation, one speaker was randomly selected. His speech was set aside as the input speech. First, the test speech was decoded by a recognizer trained only on the speech of a second speaker. The resulting word error rate was approximately 80% (Figure 11). Next the recognizer was trained on the speech of two speakers, three speakers, and so on. Word error rates dropped with the addition of more training data. We replicated the experiment under two conditions: first, speakers were added randomly from all districts; second, speakers from the test speaker's district were added first.

The results show that training a simple whole-word recognizer on the speech of approximately 15 speakers results in 2% error rates or less, which were found to be acceptable rates of error in parallel SDS user studies (Plauché & Prabaker, 2006). When fewer than 15 speakers are available for training, recognition for a given speaker is slightly better if trained on speakers from the same district.

ASR Design Considerations

The results from these ASR experiments confirm the basic principles of ASR (Table 1). Errors decrease with simple tasks, with matching input and training data, and with more training data. The specific trials shown here can inform our design for an SDS for developing regions. First, to achieve optimal usability with limited-resource ASR, our SDS design should limit the complexity of the ASR task to approximately 10 words or fewer at any given dialog node.

Our main finding in recording the speech of rural villagers of Tamil Nadu is that traditional data collection techniques favor literate speakers and that villagers only 300 kilometers apart use different words and different pronunciations for everyday concepts that are difficult to predict in advance. A speech recognizer designed to recognize the word choice and pronunciation of users in one village will likely fail for villagers a few hundred kilometers away. Likewise, the relevance of information varies from region to region (e.g., tide and sea conditions on the coast, rainwater collection in dry regions), necessitating a different set of command words in each case.

Our second proposal is the integration of speech collection into the SDS design. By recording the speech of people while they use the SDS, we can ensure that input and training data match not only in dialect, but also in other nonlinguistic factors, such as channel and room acoustics. In addition, the time-consuming, artificial step of collecting training data by recording disjointed instances of speech, which is particularly ill suited to an illiterate population, would be unnecessary. By integrating data collection into the SDS, the needs of the user (gaining access to relevant information) and the needs of the system (gathering instances of speech to enable recognition) are simultaneously met.

Finally, the ASR for each village could achieve adequate accuracy for SDS usability by cheaply and quickly initializing the models with the speech of only 15 speakers. In a later section, we will discuss language adaptation techniques that can further improve ASR performance when limited training data are available by (semi-) automatically incorporating user speech into acoustic models.

UI Design

The UI component is as important to the success of an SDS as ASR accuracy and application content. The human-computer interaction community offers these two guidelines for UI design of interactive systems (Del Galdo & Neilsen, 1996): 1. Let users feel in charge, not at the mercy of the system. 2. Spare users as much effort as possible.

An appropriate and effective user interface is one that suits the task to be accomplished. According to Lansdale and Ormerod (1994), question and answer interfaces work well when the user need only provide a small amount of information (cash machine). Repetitive tasks and tasks in which the user must provide a large amount of information before a system action can take place, are best served by form-filling tasks (calendars, travel). One strength of form-filling tasks is that they are compatible with paper-based forms (health surveys, land deed requests). Menus allow the user to choose from a set of options that need not be known in advance (information retrieval). While it is often assumed that certain dialog styles are more or less suited to novice users, it is the nature of the task that dictates appropriateness of dialog style rather than the level of expertise of the user. A spoken dialog system (SDS), which would allow users to access information by voice, either over the phone lines or at a kiosk, could play a role in overcoming current barriers of cost and literacy faced by traditional UI devices in developing regions. Speech-driven UIs are less expensive than display-based UI solutions and more accessible than text-based UI solutions. Most people in developing regions have never used a computer and generally feel uncomfortable using it for the first time for fear of breaking an expensive machine. Previous user studies (Parikh et al., 2003; Medhi, Sagar, & Toyama, 2006) in southern India found that voice feedback in the local language greatly helps with user interest and comfort.

Audio output that enhances a graphical interface or powers a telephony system can be created from speech synthesis or pre-recorded audio files. Synthesized speech may have poor pronunciation, but it requires a lesser amount of memory and offers an unlimited vocabulary. Speech synthesis is readily available for a handful of languages, using the open source, Festival system (Black, Taylor & Caley, 1999), but each new language voice requires months to develop (Dutoit et al., 1996). In our project, we relied on prerecorded speech from a native speaker for all audio output. The following sections describe some of the factors that influence the design of speech based UI in developing regions.

Literacy

Literacy is usually used to describe an individual's competency at the tasks of reading and writing, or her exposure to formal schooling. It is important to note that definitions of literacy only apply to people who live within a literate society. In traditional, oral societies, men and women of considerable learning, wisdom, and understanding, such as priests and traditional healers, transmit cultural and societal history through oral methods, though these individuals would be considered non-literate by most definitions of literacy.

In oral communities, information is primarily disseminated by word of mouth. Literacy increases access to information over wider distances in space and time. Of the estimated 880 million adults who are not literate, two-thirds are women and two-thirds live in India (Lievesley & Motivans, 2000), where health, nutrition, and earning potential positively correlate with literacy (Psacharopoulus, 1994; Census of Tamil Nadu, 2001; Borooah, 2004). In rural Tamil Nadu, illiteracy rates can be as high as 50% for men and 80% for women (Census of India, 2001).

Unschooled adults primarily rely on empirical, situational reasoning rather than abstract, categorical reasoning (Scribner, 1977). Design features considered standard or intuitive in traditional user interface literature, such as hierarchical browsing, and icons that represent concepts are found to present a challenge to individuals with no formal schooling. Researchers agree on the following requirements for user interface designs that accommodate unschooled individuals (Deo, et al. 2004; Parikh, Kaushik, & Chavan, 2003; Medhi, Sagar, & Toyama, 2006; Plauché & Prabaker, 2006):

- Ease of learning, ease of remembrance
- No textual requirements
- Graphics (and possibly speech in local language)
- Support for internationalization
- Accommodates localization
- Simple, easy to use, tolerant of errors
- Accurate content
- Robust in (potentially distracting) public spaces

Localization

For each new language and culture, the following UI design elements are subject to change: fonts, color, currency, abbreviations, dates, register, icons, concepts of time and space, value systems, behavioral systems. Traditional approaches to accessing models of culture include questionnaires, storyboards, and walkthroughs with a large sample of potential users at each stage of UI development (Schneiderman, 1992; Delgado & Araki, 2005). These user study techniques, however, present difficulties for unschooled, marginalized populations because of their daily requirements and ambient infrastructure (Huenerfauth, 2002; Brewer et al., 2006; Plauché et al., 2006). This might account for the relatively few publications reporting user studies in developing regions, despite the growing interest in researchers and developers of technology for rural populations. We predict that successful UI design for predominantly oral communities will build on existing means of information transfer and existing linguistic and cultural expertise by enabling community authorship of content.

Field Study 2: OpenSesame SDS

We developed OpenSesame, an SDS template for creating multi-modal spoken dialog systems for developing regions. We worked collaboratively with agricultural and community experts of MSSRF staff to port one unit (Banana Crop) of the text-based Valam website to the interactive OpenSesame application. User studies for the Banana Crop SDS were conducted using live speech recognition in Dindigul district, Tamil Nadu. The audio input recorded during user interactions with OpenSesame SDS served to simulate integrated data collection and ASR adaptation techniques, as discussed in the following sections.

Multimodal Prototype

The OpenSesame SDS runs on a multimodal prototype that allows both speech and touch input. The output includes graphics, a small amount of text, and prerecorded audio files. We constructed a modifiable flex button system by soldering the "reset" buttons from used computers to the function keys of a dedicated keyboard (Figure 12). The low-

Figure 12. Multimodal prototype accepts both touch and speech input.

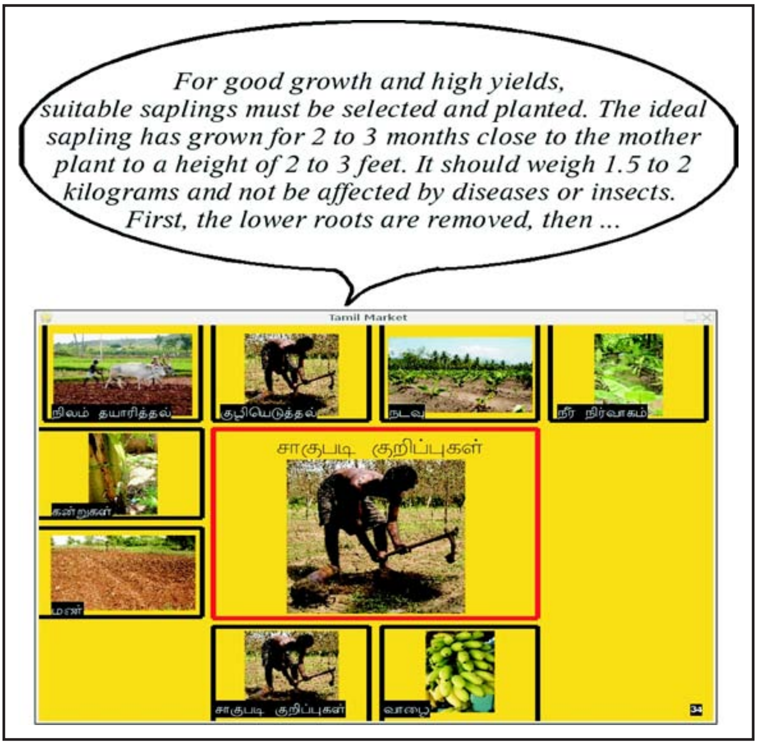

Figure 13. Screen shot of Banana Crop Application. The center square correlates to audio output, the smaller squares indicate available command options, also accessible via button panels.

cost equivalent of a touch screen (similar to ATM cash distribution machines), allows the SDS to function well in noisy environments where speech recognition fails by incorporating an additional input modality (touch). Construction of the prototype is transparent, cheap, and easy to construct from locally available materials.

Banana Crop SDS

Researchers and MSSRF staff collaborated to create an interactive version of one unit (Banana Crop) of the Valam website, using the OpenSesame SDS template. Banana Crop SDS adhered to the design guidelines for UIs previously described and was completed in less than 3 weeks. Our rapid, collaborative process involved identifying appropriate content, verifying the accuracy of the text version, gathering digital pictures, recording the speech output, and synchronizing all elements. MSSRF staff used their expertise and connections with local agricultural experts, universities, farmers, and merchants to locate relevant sites and stage demonstrations of recommended techniques. Their expertise in recommended agricultural practices informed the portrayal of content. For example, farmers identify banana varieties primarily by their fruit, not by the tree. Photos were prepared accordingly. The researchers provided design and scheduling recommendations based on the limitations and strengths of the technology. Synchronizing the images and the audio output was the most time consuming part of development, which led us to later develop a graphical user interface (GUI) editor for easy modification of OpenSesame applications.

Twenty-eight acoustically dissimilar and locally appropriate vocabulary words were selected to correspond to the Valam website subheadings (*Soil Preparation, Varieties,* etc.). The menu system was only three levels deep and presented no more than eight options at time. The system was highly redundant, explicitly listing options at every screen and disseminating information in the form of an audio slide show in Tamil when no input was provided. The result is an interactive dialog system that educates the user through digital photographs and narrative in Tamil on the recommended practices for growing, harvesting, and propagating a banana crop according to local conditions and needs (Figure 13).

Banana Crop ASR

The recognizer for the SDS must recognize multiple speakers and be robust to noisy conditions under conditions of limited linguistic data. The recognizer that powers Banana Crop SDS was trained on the transcribed Tamil speech recordings described in the previous section (Field Study 1). The speech recognizer is built using the hidden Markov model toolkit (HTK) (Young, 1996). A pronunciation dictionary was prepared by listing each vocabulary word along with its phonemic representation. Training models at the sub word level (e.g., phones and

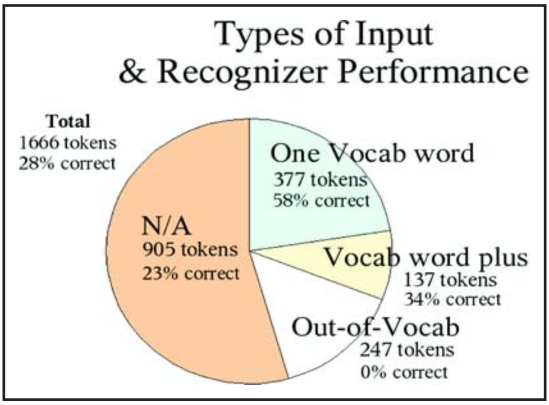

Figure 14. Categories of input from all six sessions. The percentages shown do not total 100, as they refer to the recognition results within each category, not the portion of all data the category represents. One Vocab word is referred to as the SDS Tamil 2006 database in later sections.

triphones) allow a recognizer to accommodate new words and phonetic contextual variations.

A test database was prepared by recording five MSSRF staff members saying each vocabulary word three times each to evaluate the ASR. When we trained our recognizer on monophone models, recognition on the test database yielded 73% accuracy. Triphone models (single Gaussian) performed at 97% accuracy. For subsequent user studies, our recognizer used triphone models and state-based parameter tying for robust estimation.

Field Evaluations

The Banana Crop SDS was evaluated by rural villagers in three different conditions across six different sites (Table 3). Approximately 50 people (roughly equal women and men) actively navigated the system using either touch or speech input. An estimated additional 200 people were onlookers who offered feedback based on that role. The participant's audio commands to the system were recorded during use. Sessions with each person were generally short, involved very little training, and invited informal feedback. In particular, people were asked to comment on the content, how easy the touch or voice input was to learn, and any preferences between the two modalities. We did not attempt a formal user study of the SDS. Our goal was to use the SDS to record speech during user interactions in order to design ASR adaptation techniques that would optimize performance by gradually integrating user speech into existing models.

ASR Results

The overall categories of input recorded across all sessions are shown in Figure 14. The majority of input was hand-labeled as "N/A," or "Not Applicable." This category includes sound files which are either empty, contain no speech, or contain irrelevant background speech. The recognizer correctly identified 23% of these tokens as "silence." Approximately 15% of all input were utterances directed at the application but not included in the recognizer's restricted vocabulary (out-of-vocabulary). The recognizer did not include a model for out-of-vocabulary input, so recognition performance on this set was 0%. Input that contained a vocabulary word, either alone (one vocab word) or with other input (vocab word plus), represented less than a third of all input data, and was recognized at rates of 58% and 34%, respectively.

Recognition performance on isolated vocabulary words was much worse for speech recorded during SDS interactions (58% accuracy) than for the speech recorded from MSSRF staff as they read words aloud in a quiet office (97% accuracy). Although ASR is known to degrade in noisy environments, the speech from MSSRF staff did not vary significantly from SDS sessions in signal to noise ratio, which was overall remarkably good (~20dB). The degradation is more likely due to the dissimilarity in speaking style between reading aloud and issuing commands to a machine.

Further investigation into recognition performance by site was conducted only on input comprised of a vocabulary word either alone (one vocab word) or with other speech (vocab word plus) (Figure 15). Performance does appear to be subject to social and environmental factors, as the highest rate of performance is found in the Sempatti session, a controlled user study with all literate subjects. The lowest performance occurred in S. Kanur, a farmer focus group in a much more distracting setting: a schoolroom with approximately 100 people and 2 onlookers for every participant.

Although overall recognition was poor, participants reported that the interface is easy to use. The most educated participants often commented that the system would be "good for people who cannot read." We noted that the least educated partici-

Table 3. Recording Conditions

Conditions	Users	Site Description
Controlled user study	3 men (literate)	Sempatti VRC: • One user at a time • Group feedback • 30 min. sessions • Speech only
	8 women 5 men (literacy varied)	Panzampatti VKC: • One user at a time • Individual feedback • 10–20 min. sessions • Speech and touch
Farmer focus group	15 women 20 men (literacy varied)	S.Kanur: • Group use • Group feedback • 5 min. sessions • Speech and touch
	10 women 20 men (literacy varied)	Gandhigram: • Group use • Group feedback • 5 min. sessions • Speech and touch
Village outreach	5 men (literacy varied)	Athoor: • One user at a time • Group feedback • 10 min. sessions • Speech only
	8 men 4 women (literacy varied)	P.Kottai: • One user at a time • Group feedback • 10-min. sessions • Speech only

pants preferred to listen to the system for several minutes before speaking to it. When prompted explicitly, some subjects reported preferring the touch screen as a means of input, others preferred speech. Many corrections and suggestions were offered for Banana Crop SDS, especially the addition of more crops to the system.

The three recording conditions (Table 3) were adopted out of flexibility to the available infrastructure, which ranged from a dedicated room in a village center (controlled user study) to a mat outside a home (village outreach). We tried to balance controlled user studies with existing methods of community information flow used by MSSRF (farmer focus groups). When MSSRF staff played a large role in the evaluative sessions, we observed lively and informed debates about recommended agricultural practices. MSSRF staff heard feedback from farmers who shared their successes and failures with current practices and explained what services and materials were provided at the nearby community centers. The farmer focus groups enabled us to observe the advantages of audio enabled software for multiple user settings, which were not apparent in our controlled user study conditions.

ASR Adaptation

So far, we have presented design and technology considerations for speech interfaces that meet criteria for equitable access, in particular for users in developing regions. Our belief is that speech interface solutions, especially those that can be easily modified by local experts, can allow oral populations access to digital, local resources. The technology that powers such a speech interface must also be easily customizable to new languages and dialects. Here, we introduce ASR adaptation, a technique for automatically or semiautomatically optimizing a recognizer by gradually integrating new, untranscribed data into the models for speech. Small vocabulary speech recognizers that are initialized with available data then tuned to user speech input with adaptation techniques can scale to new domains and new dialects more quickly and more affordably than large vocabulary, continuous speech systems.

Cross-Language Adaptation

Only a handful of speech technology efforts (Nayeemulla Khan & Yegnarayana, 2001; Saraswathi & Geetha 2004; Udhyakumar, Swaminathan, & Romakrishnan, 2004) have been dedicated to Tamil, which is spoken by more than 60 million people in

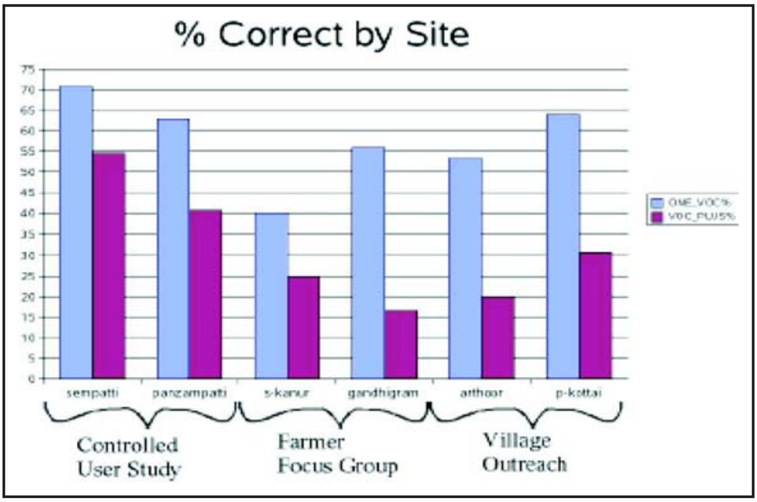

Figure 15. Recognition performance by site.

Tamil Nadu, Sri Lanka, and throughout the world (Comrie 1987). When annotated corpora for a given language are limited or unavailable, as is the case for most languages spoken in developing regions, a recognizer trained on transcribed data from one or more (source) languages, can be used to recognize speech in the new (target) language. This technique, called *cross-language transfer,* yields the best results when the source and target languages are linguistically similar and when the recognizer is trained on multiple languages.

Language adaptation is a technique in which the recognizer is trained on a large source language corpus and then the acoustic models are adapted to a very limited amount of target language data. Performance correlates to the amount of data available in the target language and the number of different speakers used for training. During *bootstrapping,* acoustic models are initialized from a small amount of transcribed source data. The speech recognition system is then iteratively rebuilt, using increasing amounts of training data and adaptation (Schultz & Waibel, 1998; Kumar & Wei, 2003; Udhyakumar et al., 2004).

Table 4. Language Adaptation Techniques and Data Conditions[1]

Adaptation Technique	Availability of Data
Cross-language Transfer	No data
Language Adaptation	Very limited data
Bootstrapping	Large amounts of data

[1]*See Waibel et al., 2000.*

Experiment 4: English-to-Tamil Adaptation

Based on the speech we collected in the field with Banana Crop SDS, we ran a series of recognizer experiments to determine how to optimize the small vocabulary recognizer to the speech of a particular community given no or limited Tamil training data. We simulated ASR performance under conditions of no available training data (cross-language transfer) and very limited training data (language adaptation) using the following databases: SDS Tamil 2006, Tamil 2006, Tamil 2005, and English TIMIT (Table 5).

In the field, the recognizer trained only on Tamil 2005 data recognized commands for Banana Crop SDS with 58.1% accuracy. We noted a substantial improvement (68.7%) with the addition of cepstral mean subtraction, an increase in model size from single Gaussian to 16 Gaussians, and the collapse of certain contrastive phonetic categories (long vs. short vowels) in the pronunciation dictionary (Figure 16). Simple noise robustness methods such as cepstral mean subtraction factor out environmental noise and generalize across tasks and speakers.

When an annotated corpus for a given language is unavailable, the options are to build one by collecting and transcribing speech, as we did in 2005, or to train a recognizer on an available corpus in another language. We first mapped the Tamil phonemes to English phonemes as closely as possible. Then, training and decoding were performed using HTK (Young, 1997). The acoustic models are trained first with a default flat initialization. Then triphone models are developed based on monophone HMMs and the recognizer decodes in a single pass using a simple, finite state grammar. Test results for the recognizer on speech input from the field (SDS Tamil 2006) show that the accuracy was significantly better when trained on a small amount of same language data than when trained on a greater amount of mismatched data. A Tamil SDS powered by a recognizer trained on English speech would only predict the correct word 30% of the time.

Table 5. English and Tamil Data Sets

Data Set	Size	Dictionary Size	Description
SDS Tamil (2006)	Very small (377 words)	Very small (28 words)	Agricultural words spoken by villagers retrieving information from Banana Crop SDS indoors and out in Dindigul district
Tamil (2006)	Very small (170 words)	Very small (28 words)	Same agricultural words read out loud by MSSRF staff in a fairly quiet office in Dindigul district
Tamil (2005)	Small (10K words)	Very small (50 words)	Digits and verbs read or guessed out loud by speakers of all literacy levels indoors and out in three districts
English (TIMIT)	Medium (50K words)	Medium (6K words)	Phonetically balanced sentences read out loud in a quiet laboratory setting

Finally, we initialized the recognizers on either English or Tamil, as described above, and then adapted the recognizer to the very small database of Tamil speech collected from five volunteers from the MSSRF staff (Tamil, 2006) using maximum likelihood linear regression (Young, 1997). The Tamil 2006 database is an available, yet very limited, language corpus that was rapidly collected and annotated (approximately 1 hour of nonexpert time). Adaptation to Tamil 2006 improves performance for both the recognizer trained on English and the recognizer trained on Tamil. It is interesting that the results are comparable (82.2% and 80.4%, respectively). There is very little to be gained by collecting and annotating a corpus like Tamil 2005, which took an estimated 100 hours of expert time, when adapting an English-trained system to a very small, easily prepared data set like Tamil 2006 yields similar results. This technique is supervised, as the adaptation data is manually transcribed before adaptation.

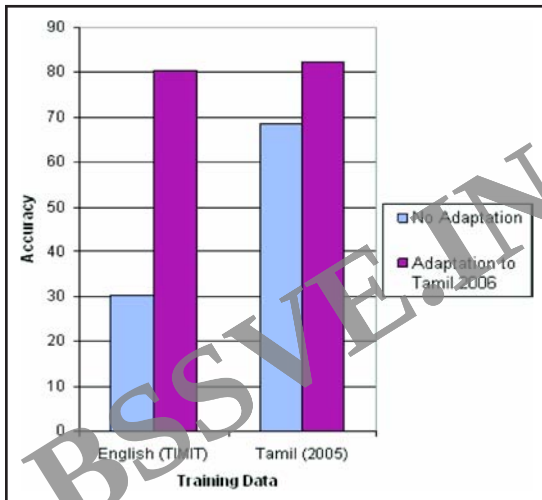

Figure 16. Accuracy of ASR on SDS Tamil 2006.

ASR adaptation can overcome the high costs of recording and annotating a large training corpus. Adaptation can also be *unsupervised* when a recognizer is automatically improved by gradually integrating new, untranscribed speech into intialized acoustic models (Kemp & Waibel, 1999; Lakshmi & Murthy, 2006). A confidence measure is used to rank the data; those with the highest scores are selected for integration. Similar adaptation efforts have sought to include, yet minimize, human participation for training acoustic models. In *supervised adaptation,* the utterances with the lowest confidence scores are deemed to be the most informative. They are automatically selected for hand transcription and integration into the training data, resulting in a reduction of the amount of labeled data needed by as much as 75% (Lamel, Gauvain, & Adda, 2000; Riccardi & Hakkani-Tür, 2003). Further exploration of (semi-) automatic adaptation techniques will surely result in robust, rapid development ASR for limited-resource environments.

Future Plans and Conclusions

This article reviews literature on the language, access, and information requirements likely to be found in primarily oral, limited-resource environments. Speech technologies and techniques that are small, scalable, and easy to modify and update by local stakeholders in community development can be constructed to deliver accurate, locally relevant information to individuals regardless of their literacy level. Integrated data collection and language adaptation are found to be useful techniques for collecting linguistic resources according to both user and system needs.

In future studies, we plan to determine the smallest amount of adaptation data required to reach adequate levels of ASR accuracy. We would also like to explore how speech/no speech detectors and out-of-vocabulary models could play a role in a robust, adaptive SDS/ASR system. Recall that 75% of SDS input consisted of unusable data. We envision an SDS that is initialized with a large amount of available data perhaps from a different language, then as it is used in a village or community, participants' speech is recorded, prefiltered, and gradually integrated (automatically or semiautomatically) to adapt to the dialect and speaking style. We hope to see further work in simple, affordable designs for speech synthesis and UI, especially for text-free browsing and searching across libraries of audio and digital media. ■

Acknowledgments

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Fall 2008

Thrive in 5 program

Thrive in 5 Baby Blog

Rashmi Melgiri, MIT
& three anonymous MIT students
Patty Furukara, Emerson
Luis Sarmenta, Team Advisor

December 10, 2008

Development gap due to parent's lack of information or forgetfulness.

Resource	Accessibility	Timeliness
Physician	Physicians have limited time	Visits every 1 to 6 months but little contact between.
Books and Print Pubs	Government publications free. Private resources costly.	Static. Relies on parents to reference it frequently.
Web Content	Free for those with web access, but many without internet access at home.	Static. Possibility for timed newsletter or email.

The City of Boston currently works to improve access to information through free publications and playgroups.

- Milestone calendars
- Neighborhood playgroups

Full value not seen due to continuity and timeliness.

- Often misplace/don't refer to calendar
- Parents must find time to attend play groups

Baby Blog overcomes access and timeliness by bringing parents the right information at the right time.

Access

Cell phones/SMS

Ensures parents receive messages instantly

Timeliness

Timed Delivery

Child's age or neighborhood trigger when message sent

Early Words program

Countdown to Kindergarten Boston

Talk, Read, Play program

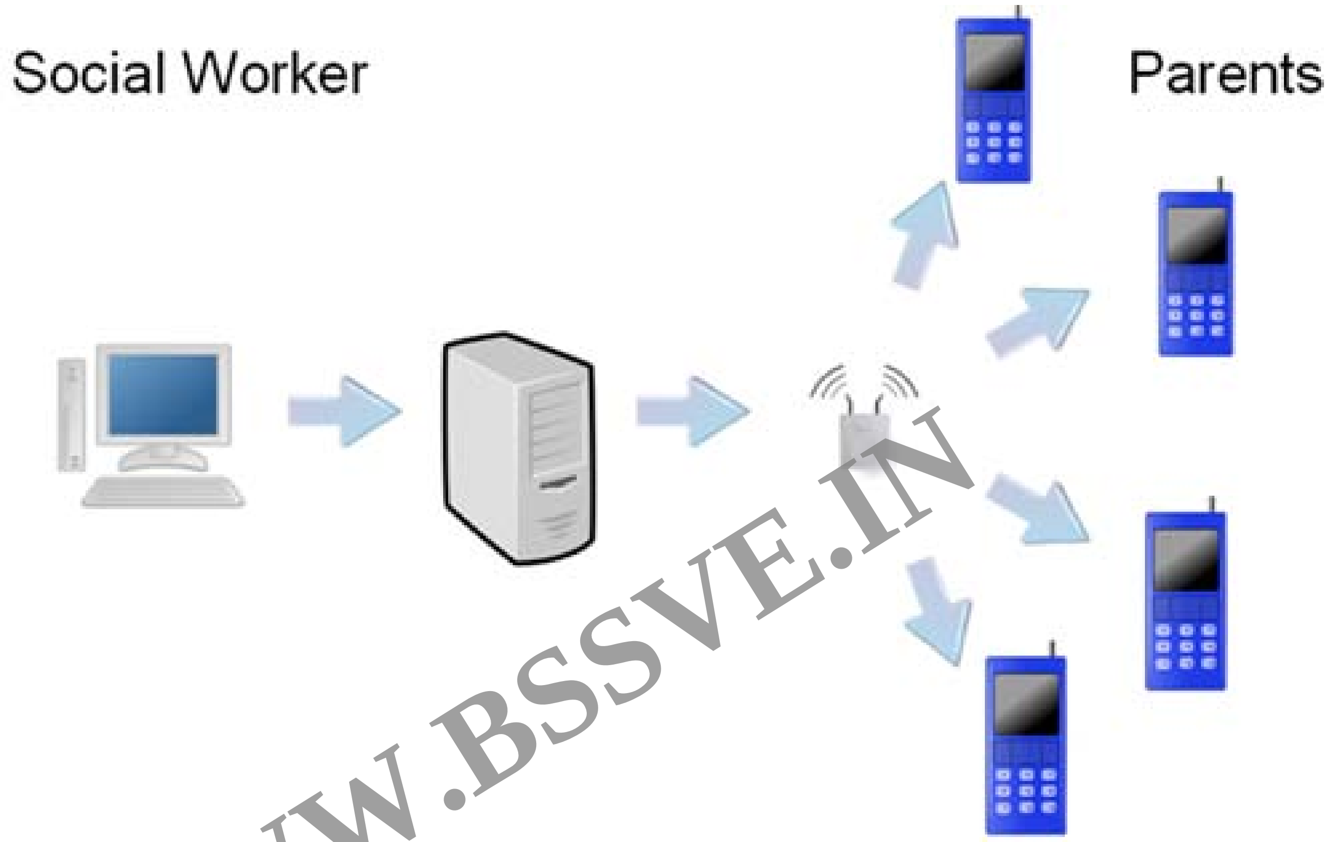
The Baby Blog system consists of 2 current pieces and a future piece, in development.

1. Content /Db Management System

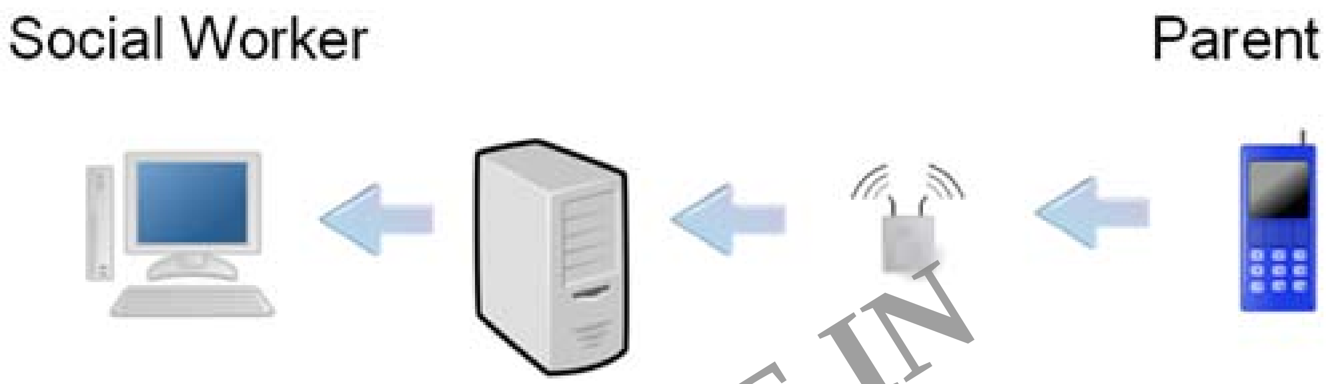
2. SMS-to-parents interface
   1. Age based messages
   2. Calendar based messages
   3. Reply by keywords

3. Parent's Baby Blog website

System Architecture - Outgoing Messages



System Architecture - Incoming Messages



The system currently supports two use cases.

- Case 1: Updating the calendar

The system currently supports two use cases.

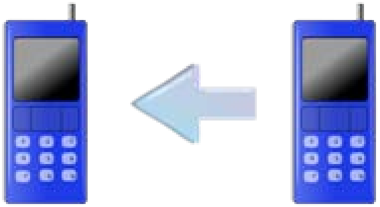
- Case 2: Notifying changes

Due to comparable cost, ease-of-use and flexibility, the system should be sustainable.

- Financial Sustainability
  - Cost savings through reduced printing
  - Increased return on investment
- Continuation Plan
  - City of Boston Technology Officer
  - Content managed by social workers

In future versions, we hope to increase accessibility and desire to access.

Furthering the goal of increased access, we will soon add **registration by SMS**.



The system brings resources to those seeking them.

But how can we combat apathy?

To get this information out to parents who are not seeking it, we will build a parent-facing site.

The current and future Baby Blog system will help reduce the achievement gap.

1. Increase # of informed parents in Boston
2. Increase # of local experts
3. Project is expandable to any social outreach group in Boston
4. Similar application could be used in other cities

Acknowledgements

Katie Britten, City of Boston

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Kate Weldon, Children's Hospital

Nigel Jacob, City of Boston

Krystal Beaulieu, Countdown to Kindergarten

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Thrive in 5 program

BabyBlog

Rashmi Melgiri
& three anonymous MIT students

Elevator Pitch

The Thrive in 5 BabyBlog is a SMS based technology that will provide a novel way to access parenting resources. Previously information for parents was available on the web or in print and was either unaccessible from home or easily lost. With this project information relevant to a parent's child will be sent direclty to parent's mobile phones or email, making it more accessible to all of Boston's parents.

What is the Thrive in 5 Baby Blog

- SMS edited Baby Blog
- Age specific reminders
- Community specific information
- Data collection for Boston's educational outreach programs
- Health information collection

Current Situation'

- Paper mailings
- Poor attendance at scheduled events'
- Limited access to internet at home
- SMS is popular mode of communication

Similar Technologies

- Twitter, SMS based blog and social network
- Google Health, personal health database shared with physician
- Websites that offer personalized parenting advice, tools and communities
  - TheBump.com (from theKnot.com)
  - babycenter.com
  - parents.com
- http://my.babyblog.com/, RSS feed of parenting related articles

Our Solution

Database:

- Parent's Name
- Child's Birth Date
- Mobile Number
- Mobile Service Provider
- Neighborhood

Server:

- Baby Blog Website
- Organization Back End

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BabyBlog: Sustainability

Milestone 4

November 5, 2008

Rashmi Melgiri
& three anonymous MIT students

BabyBlog

- Our partners' (Thrive in Five, Countdown to Kindergarten, Read Boston) goal is to decrease disparities between children 0-5 years old
- Use text messages to communicate with parents to decrease these disparities
  - Outgoing messages
  - Incoming messages
  - Blogging messages

Technology

Administrators Parents

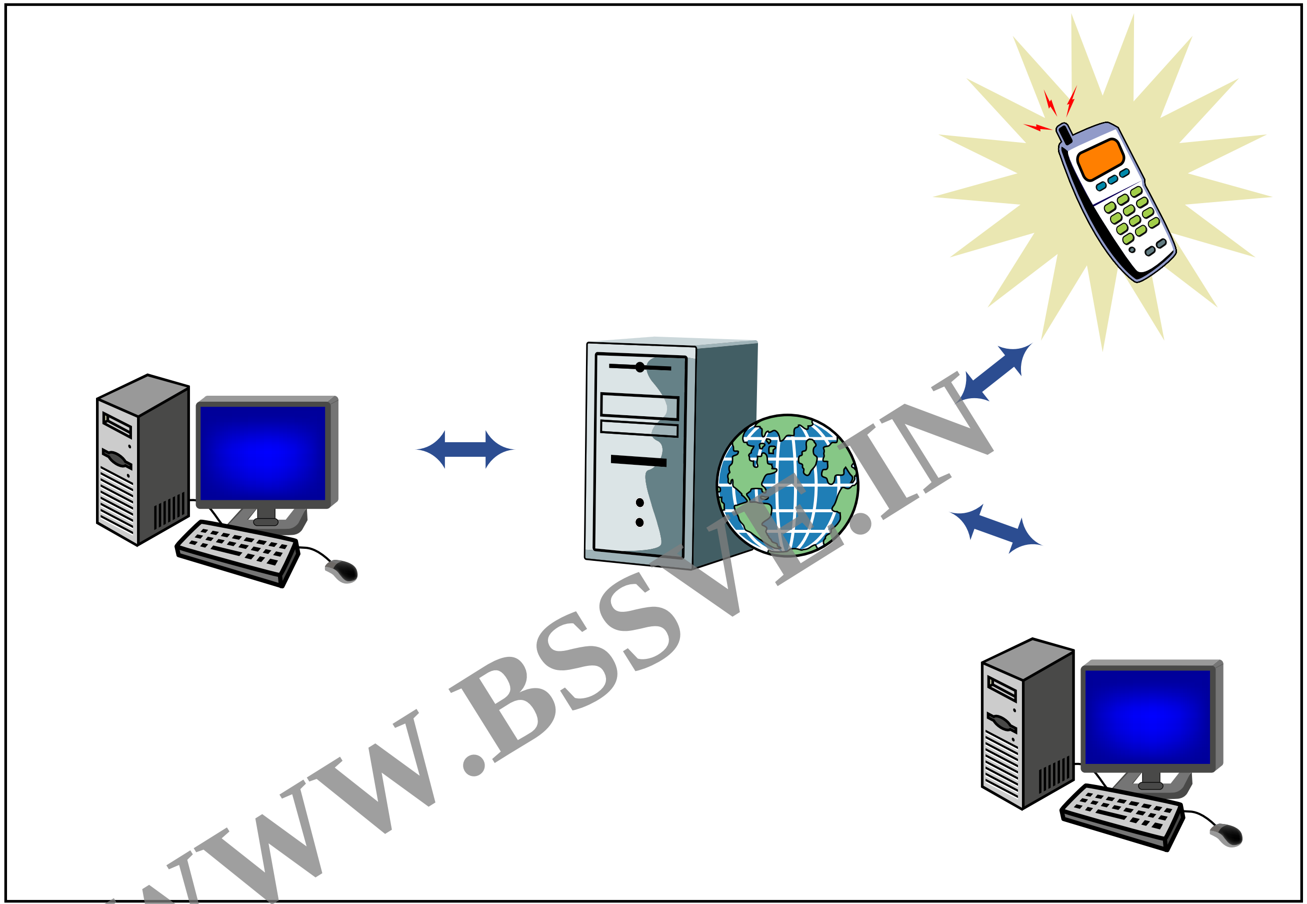

Figure by MIT OpenCourseWare.

Financial - Moving to a SMS service saves the city printing and distribution costs

Old Way

	Up-front	Mo 1	Mo 2	Mo 3
City of Boston Costs				
Printing 5000 calendars	$7,000			
Personnel				
man-hours creating calendar	100			
man-hours in physical distribution		40	40	10
avg. wage	$ 31	$ 31	$ 31	$ 31
Cost of man-hours	$ 3,125	$ 1,250	$ 1,250	$ 313
Total Cost to City	**$ 7,000**	**$ 1,250**	**$ 1,250**	**$ 313**
Users Cost				
None				
Total Cost	**$ 7,000**	**$ 1,250**	**$ 1,250**	**$ 313**

New Way

	Up-front	Mo 1	Mo 2	Mo 3
City of Boston Costs				
Messaging Costs				
# users		3,200	3,200	3,200
# children 0-5/user		2	2	2
# msgs/child/mo.		2	2	2
# mgs/mo.		9,600	9,600	9,600
Cost of sending msgs thru Clickatell		$540	$540	$540
Short Code				
Vanity shortcode (5 or 6 digit)	$1,700	$1,600	$1,600	$1,600
Personnel				
# people using system		6	6	6
# hours/mo interacting		2	2	2
total user hours/mo		12	12	12
avg. wage		$ 31	$ 31	$ 31
Cost of man-hours		$ 375	$ 375	$ 375
Total Cost to City	**$ 1,700**	**$ 2,515**	**$ 2,515**	**$ 2,515**
Users Cost				
Messaging Costs				
# users		3,200	3,200	3,200
% with unlimited txt plans		80%	80%	80%
% paying per msg		20%	20%	20%
# children 0-5/user		1.5	1.5	1.5
# msgs/child/mo.		2	2	2
# mgs/mo.		1920	1920	1920
price to receive a sms		$ 0.15	$ 0.15	$ 0.15
Total Cost to Users	**$ -**	**$ 288**	**$ 288**	**$ 288**
Total Cost	**$ 1,700**	**$ 2,803**	**$ 2,803**	**$ 2,803**

Sources: Clickatell pricing wizard; Digital Room pricing calculator

Financial – Automation and tracking in the new system provides previously unattainable benefits

- Print/physical distribution system provided little or no mechanism for evaluation
- The new system encourages and accommodates feedback, allowing the city to:
  - Finally evaluate ROI
  - Change direction/messaging mid-year if necessary
- The new system frees up valuable man-hours at the city, allowing staff to spend more time on outreach

Operational and Human

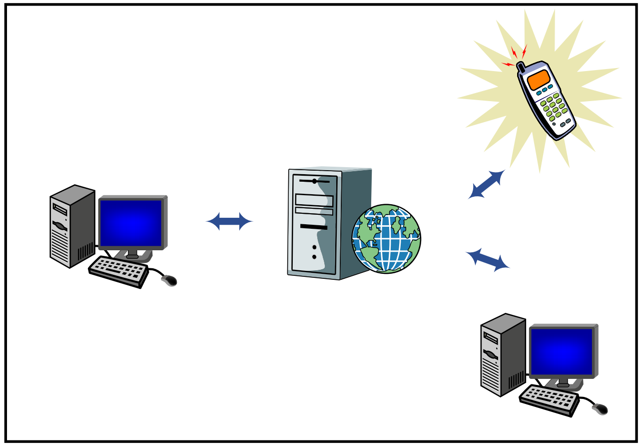
Figure by MIT OpenCourseWare.

- Technology
  - Message database
  - Web (parent facing, administrative)
  - SMS
- Requires initial development, minimal ongoing maintenance
- Additional effort needed for addition of features
- Maintained by City Technology Officer

Operational and Human

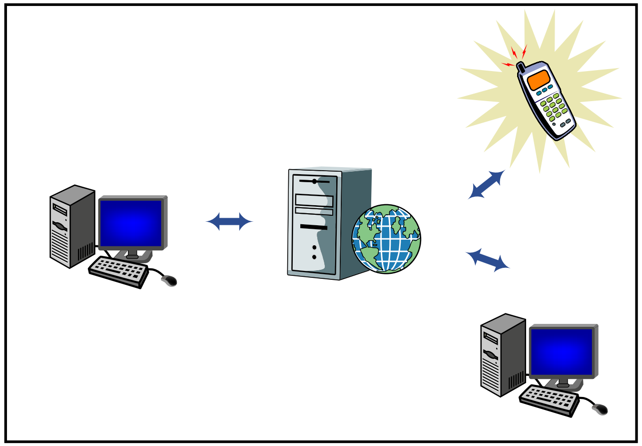

Figure by MIT OpenCourseWare.

- Outgoing Content
  - Web interface allows users interact with message database
  - Social Workers add and remove messages as needed
  - Our project partners have expressed willingness and ability to maintain

Operational and Human

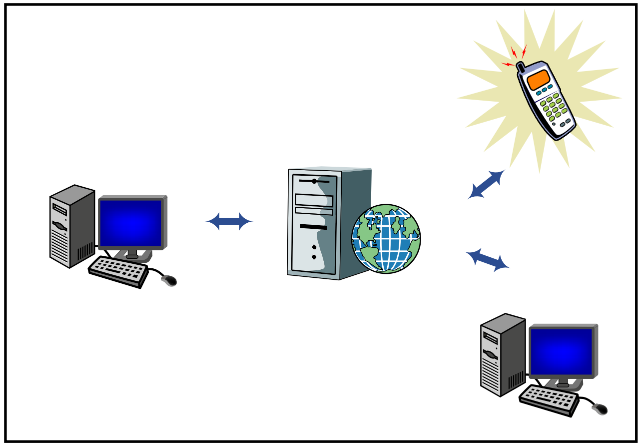

Figure by MIT OpenCourseWare.

- Parent interaction
  - Parents receive and send messages
  - Parents update profile and subscription status
  - Parents expressed interest in this mode of communication
  - Physicians/social workers endorsed this method of communication

Operational and Human

- Future NextLab students
  - Advanced feedback collection
  - Social interaction
  - Registration/referral method
  - Communication with doctors

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Giving Farmers a Fighting Chance:
Transforming the Rural Economy in Zacatecas, Mexico through Mobile Technology

MIT Team
Scot Frank
M. Ehsan Hoque
& two anonymous MIT students

Advisor
Esmeralda Megally

Media Partners
Luke Einsiedler
Paul Moore

Community Partner
Geoff Groesbeck

Background

Zacatecas, Mexico – Agricultural State

Map: Wikipedia

- 8th Largest and 2nd poorest state
- Word of mouth communication

Project Partner

Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM Zacatecas)

Strategy

Farmer's dilemma

- No market price information
- No negotiation power with traders and middlemen
- No profits. Unsustainable conditions

Technology Platform

- Improve Communication among the farmers
- Aggregate crop information
- Access market information

Desired Outcome

1. Better Information access & increased Negotiation power
2. Equitable Price
3. Increased Social Mobilization

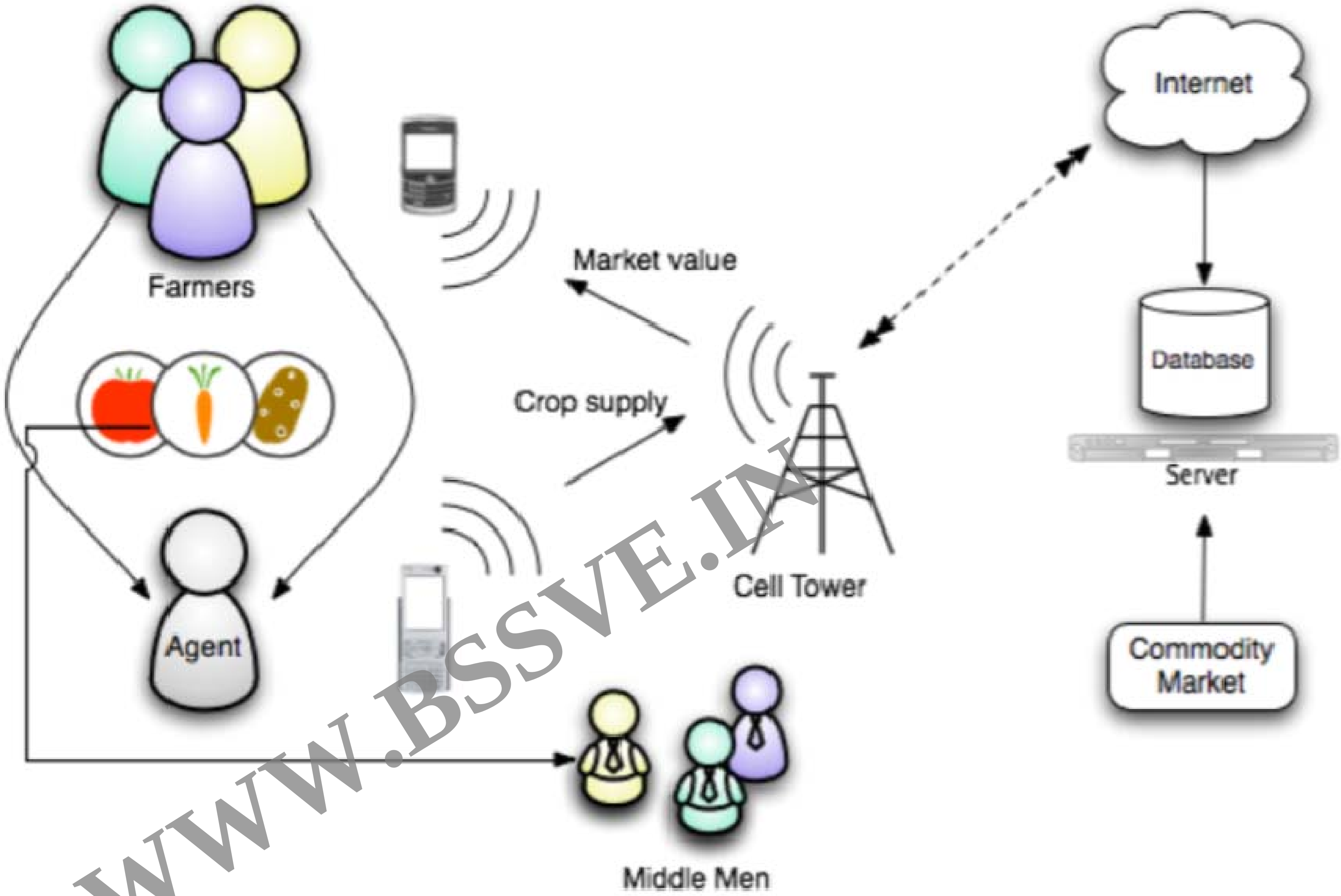
Desired Impact

Transparent Market

Fair bargain abilities for all

→ Self-sustainable Agricultural Livelihood

System Architecture



Crop Data Collection

- **Agent**
  - Register Farmers
  - Aggregate crop information

Figure by MIT OpenCourseWare.

Crop Market Price Query

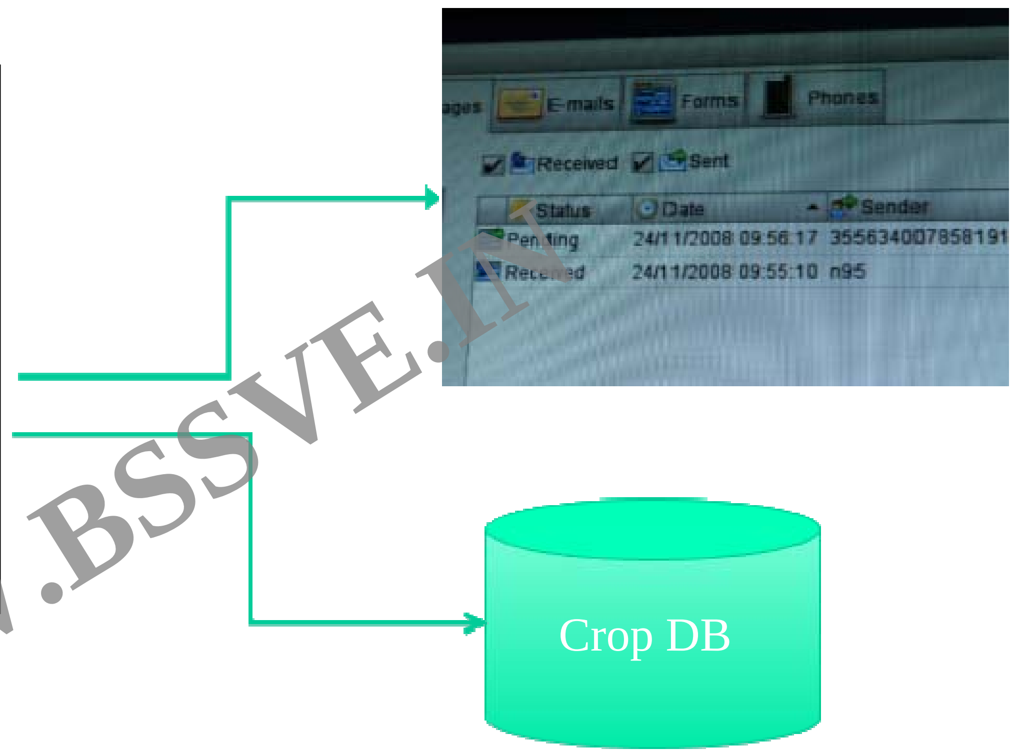
- **Farmer**
  - o Report crop yield and trades to the agents
  - o Query crop market price

Figure by MIT OpenCourseWare.

Systems Management

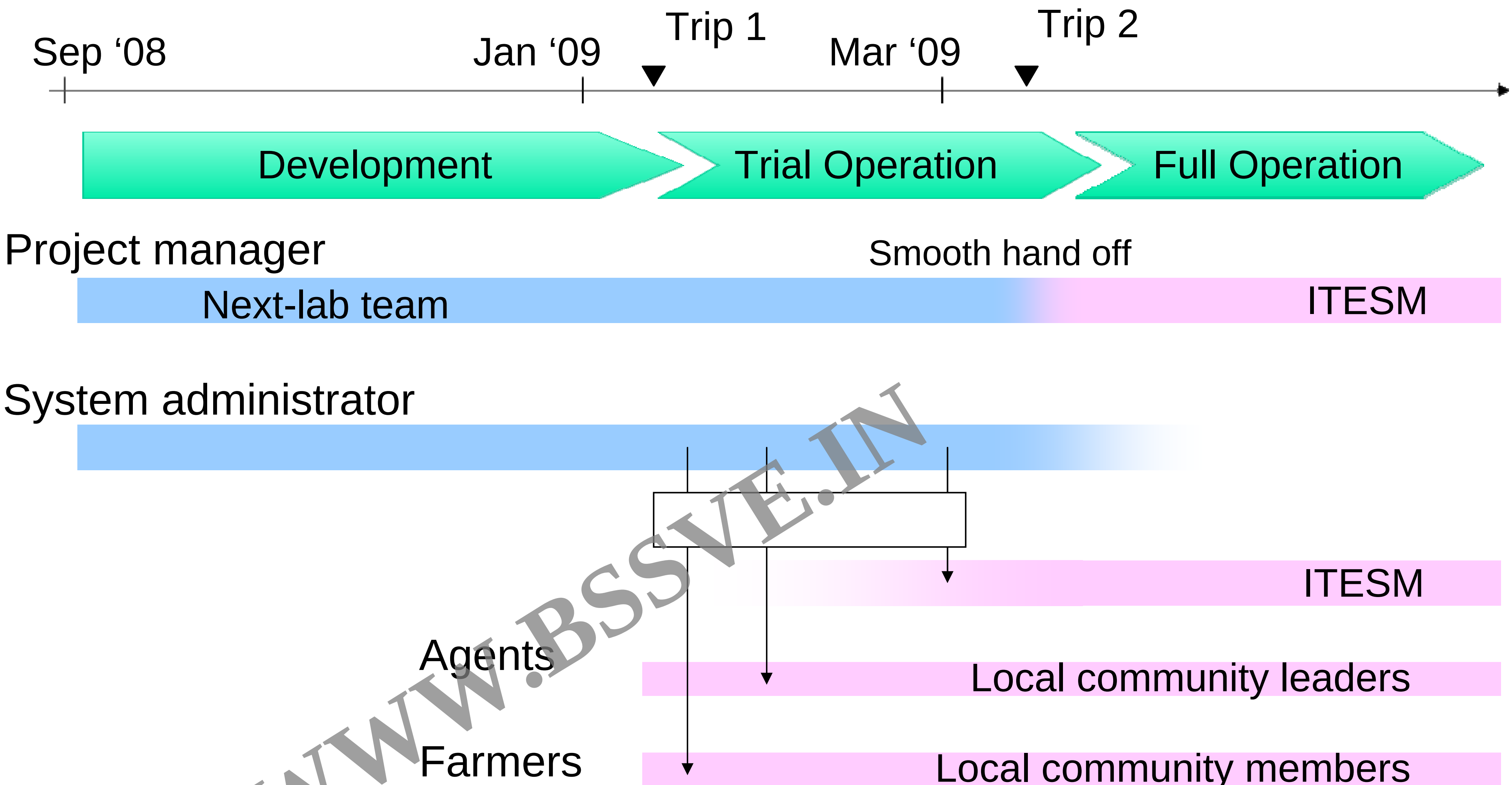
- **Administrator**
  - o Manage server application and database

Figure by MIT OpenCourseWare.



Demo

Operational Sustainability



Financial Sustainability

Jan 2009 Spring 2009

Trial Operation → Full Operation → Matured

20 — # Farmer Communities — 722 (Covering all Zacatecas State)

$2,000/yr — A Farmer's Income — $3000/yr

Cash Out (to be supported by public/private funds)

$300 for 3 mon. → $6,000/yr

- Investment in equipment is supported by ITESM
- Operation is helped by volunteer farmers and ITESM students
- etc.

Cash out by investment $500/yr
Cash out by operating $5,500/yr
(Assumption)
- office space offered by ITESM
- helped by volunteer farmers
- etc.

Rollout Plan

Trial Operation → **Full Operation** → **Maturity**

Trial Operation

- MIT Team Visit 1
  - Jan 2009
- Fund
  - $5,000 from NextLab & partners
- Agenda
  - Deploy the prototype.
  - Train agents, and farmers.
  - Collect feedback and improve the system.

Full Operation

- MIT Team Visit 2
  - Mar 2009
- Fund
  - Seeking grants
- Agenda
  - Deploy the final system.
  - Train the technology partners
  - Handoff the project

Maturity

- Maintained by ITESM
  - Funded by farmers and other stakeholders
  - Platform extended to other value added services

The Future

Community, Government, Corporations

- Government - provide monitoring, educational and informational services
- Corporations - provide storage and logistics services

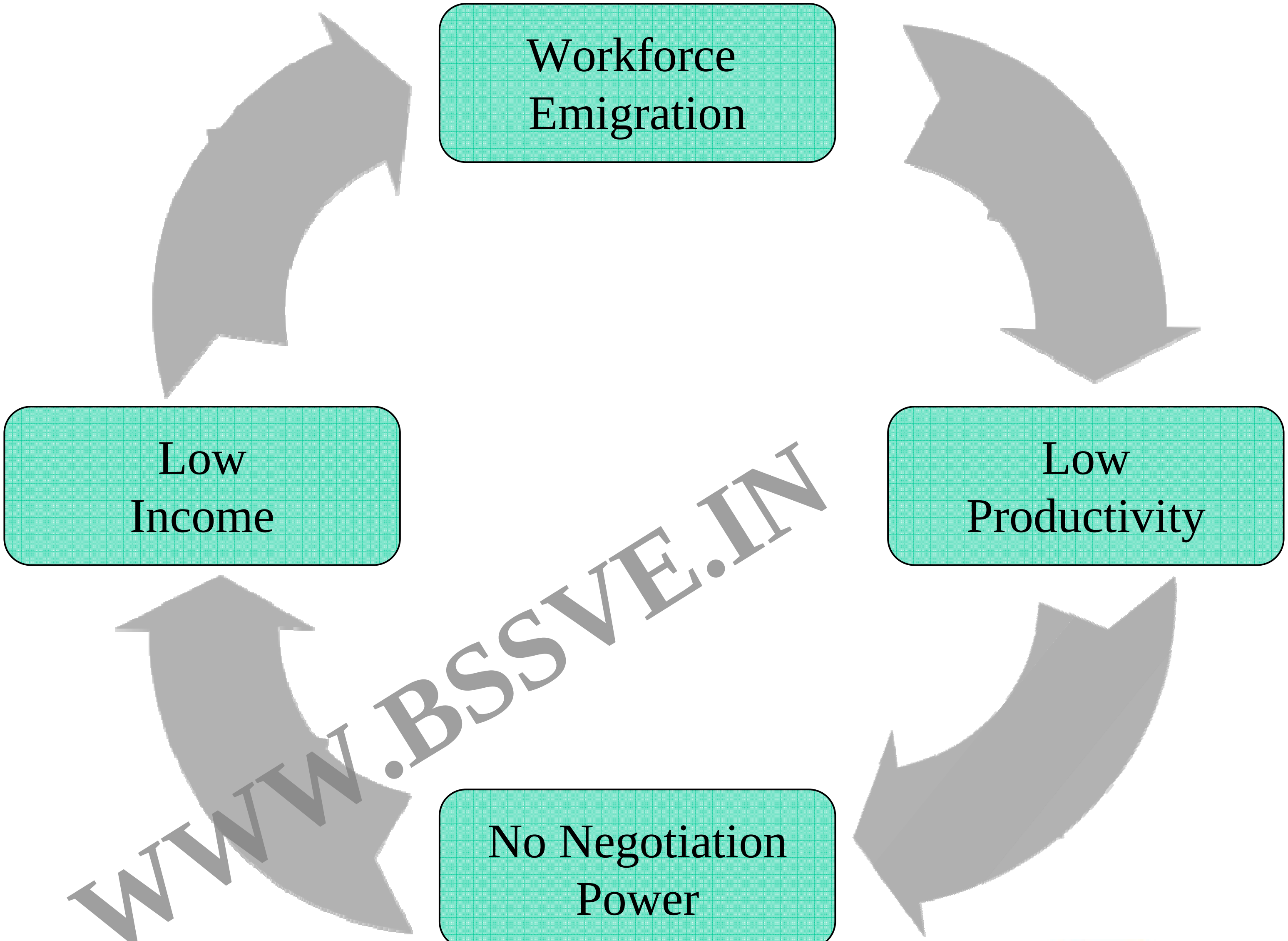
Traders, Retailers, Wholesalers

- Publish demand information. Benefits – stable supply & economies of scale
- New traders can participate in the online marketplace

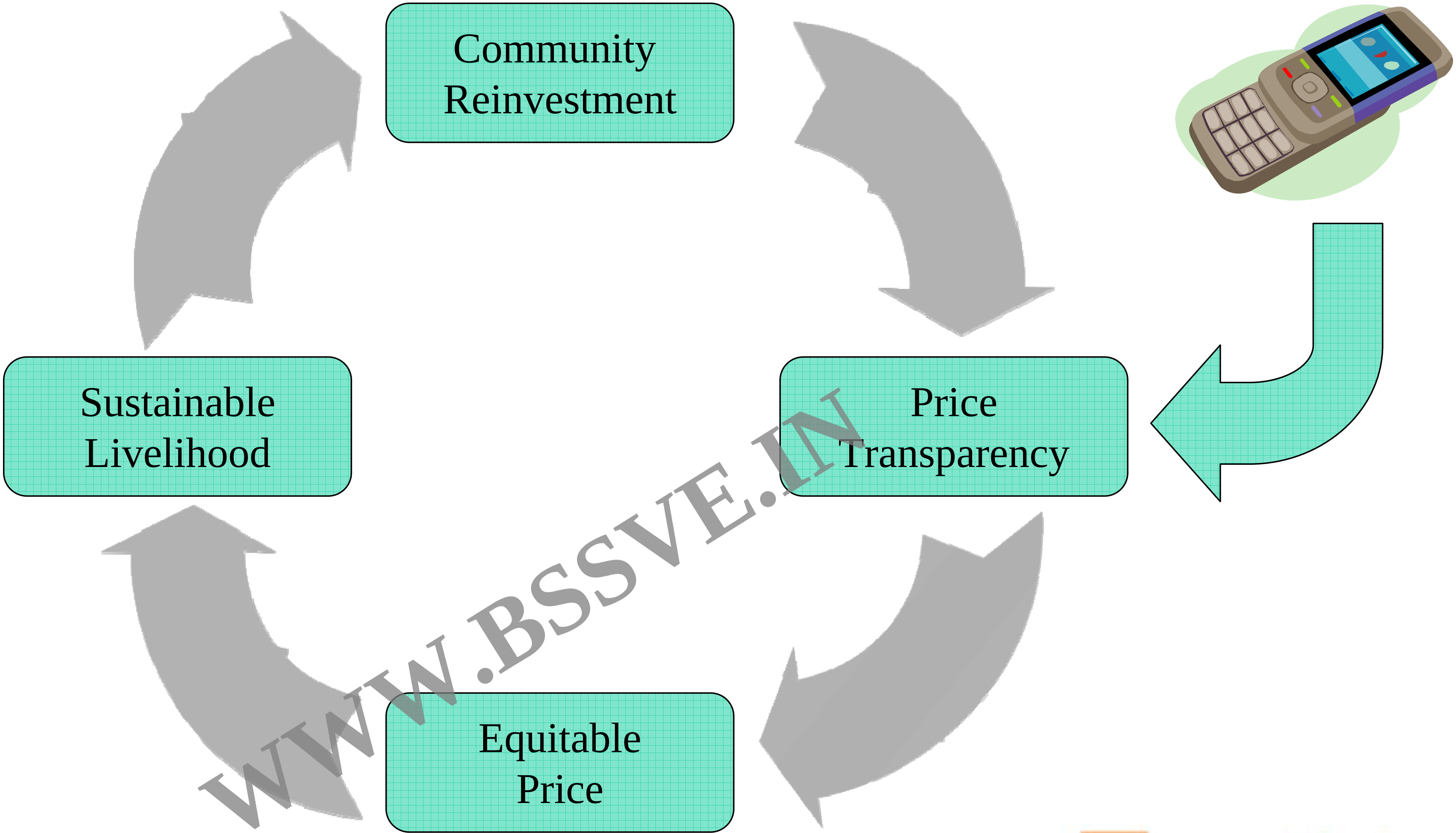
Farmers

- Lock-in future prices based upon demand information
- Use mobile platform to invest in other social programs

Vicious Cycle of Poverty



Virtuous Cycle of Prosperity



Your turn...

- To: **617-909-5107**
- Message: "**query *crop***"
  - Where *crop* is your favorite of the following:
    - tomatoes
    - potatoes
    - wheat
    - grapes
    - apples
    - corn

Questions

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Giving Farmers a Fighting Chance:

Transforming the Rural Economy in Zacatecas through Mobile Technology

MIT NextLab Team
Luke Einsiedler (Emerson)
Scot Frank (EECS)
M. Ehsan Hoque (Media Lab)
Paul Moore (Emerson)
& two anonymous MIT students

THE PITCH

"Fighting for Farmers" is an information aggregation system that will provide rural farmers access to inter-farm communication regarding crop supply, buyer demand, and market price heuristics.

Our solution will empower the farmers and facilitate equitable trade leading to a sustainable livelihood.

Need Identified

Map: Wikipedia.

Zacatecas State - A major supplier of agricultural produce which is its key economic driver.

- Lack of communication between the rural communities.
- No access to distribution and storage centers
- No Government price support mechanisms.
- At the mercy of middlemen who pay next to nothing for produce.
- Communities remain locked in a perpetual cycle of poverty.

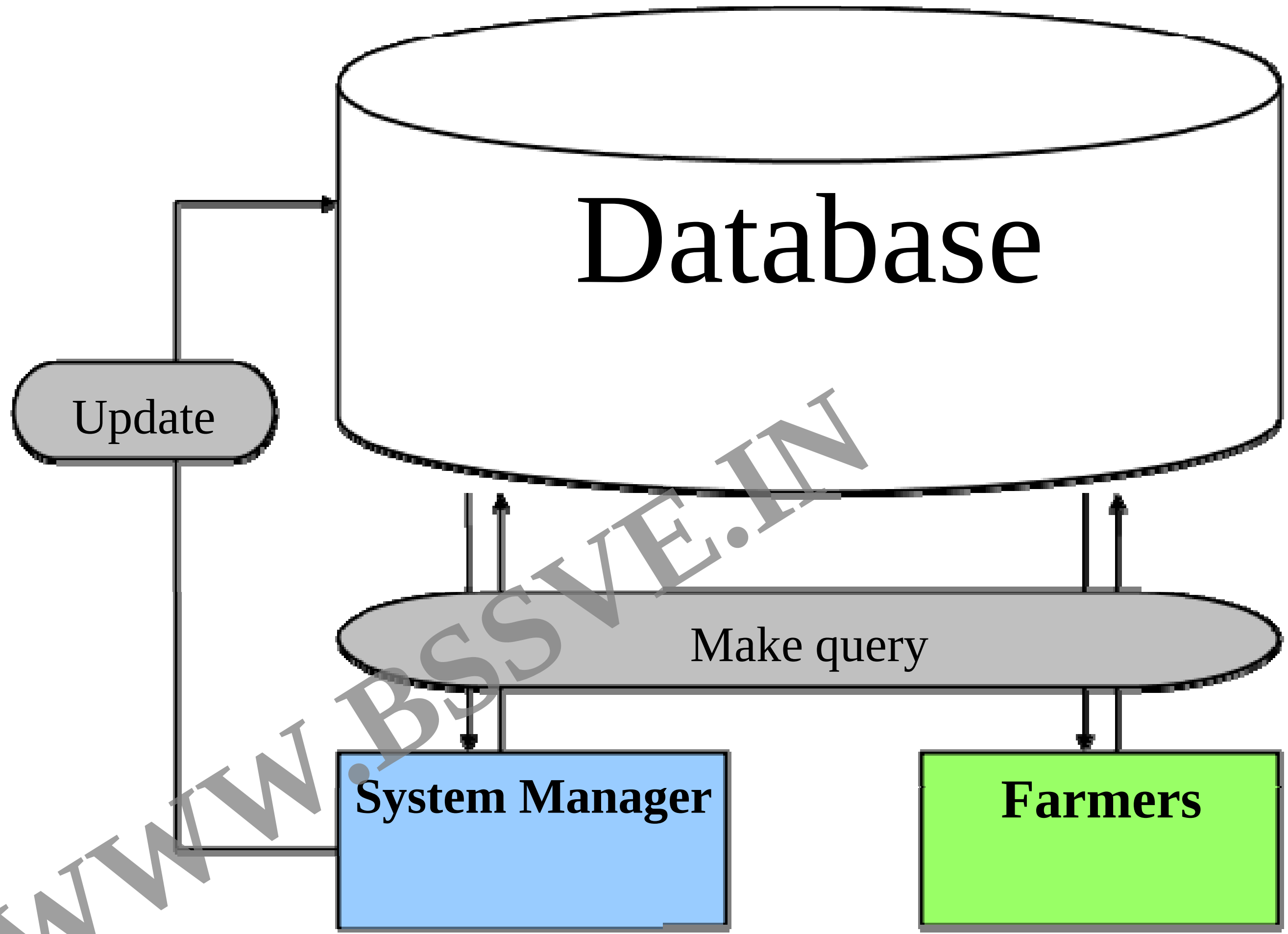
System Overview

Communication tools and databases will be built utilizing already-present technologies.

The information and logic in the system will provide them with real, current, and quantitative indicators and equip them with the necessary tools to succeed.

Project	Country	Start Year	Run By	Media	Content	Tech Partner
EAAI	Uganda	2005	WOUGNET	SMS	- Agri Tech Info - Agri Market Info	Hivos IICD
SMS Sokoni	Kenya	2003	KACE	SMS	-Commodity price - offers to sell/buy	Safaricom
Xam Morse	Senegal	2001	Manobi	SMS	- Agri market inf. - Offer to sell	Sonatel
TradeNet	Ghana	2004	TradeNet	SMS	- Fair Price - Offers to sell/buy	BusyLab
AMIS	Bangladesh	2007	Ministry of Agriculture	SMS	- Commodity price	Grameen phone BRAC
eChoupal	India	1999	ITC	Web	- Online trade - Agri market inf. - Agri tech inf.	

System Architecture



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Fall 2008

Giving Farmers a Fighting Chance:

Transforming the Rural Economy in Zacatecas through Mobile Technology

Milestone 2 beta

INTERVIEW

Sponsor Interview (Voice of the Customer)

1. Lack of communication & coordination between the communities.
2. No access to distribution and storage centers
3. No Government price support mechanisms.
4. No demand information from the wholesalers.
5. No bargaining power with the middlemen.

Key Drivers

1. Access to Market Price Information
2. Share information and pool together to get negotiate better price
3. Solution must link together with central data repository. Farmers willing to go to a data center and have expert enter data for them
4. Literacy rate is high but there will be technology training challenges. Instant messaging not widely understood.
5. Mobile penetration is low but cell phones are affordable (as low as $40). But must also have to factor in connectivity charges.
6. Low operating cost is key. Must be economical & sustainable.

CASE STUDIES

- Xam Marse (Senagal - 2001) *free-access SMS market information system*
- EAAI (Uganda – 2003) *Information-Partner-Provider communication channel*
- Trade Net (Ghana - 2006) *Market information service for farmers and traders*
- eChoupal (India – 2000) *Information-Partner-Provider communication channel*

PARTNER FEEDBACK

Questions:

1. Farmer unification on selling price
2. Availability of market price on commodity goods
3. SMS cost structure/usage
4. Additional cultural/engineering context
5. Anti-trust case
6. *Explain & Describe proposed solution*

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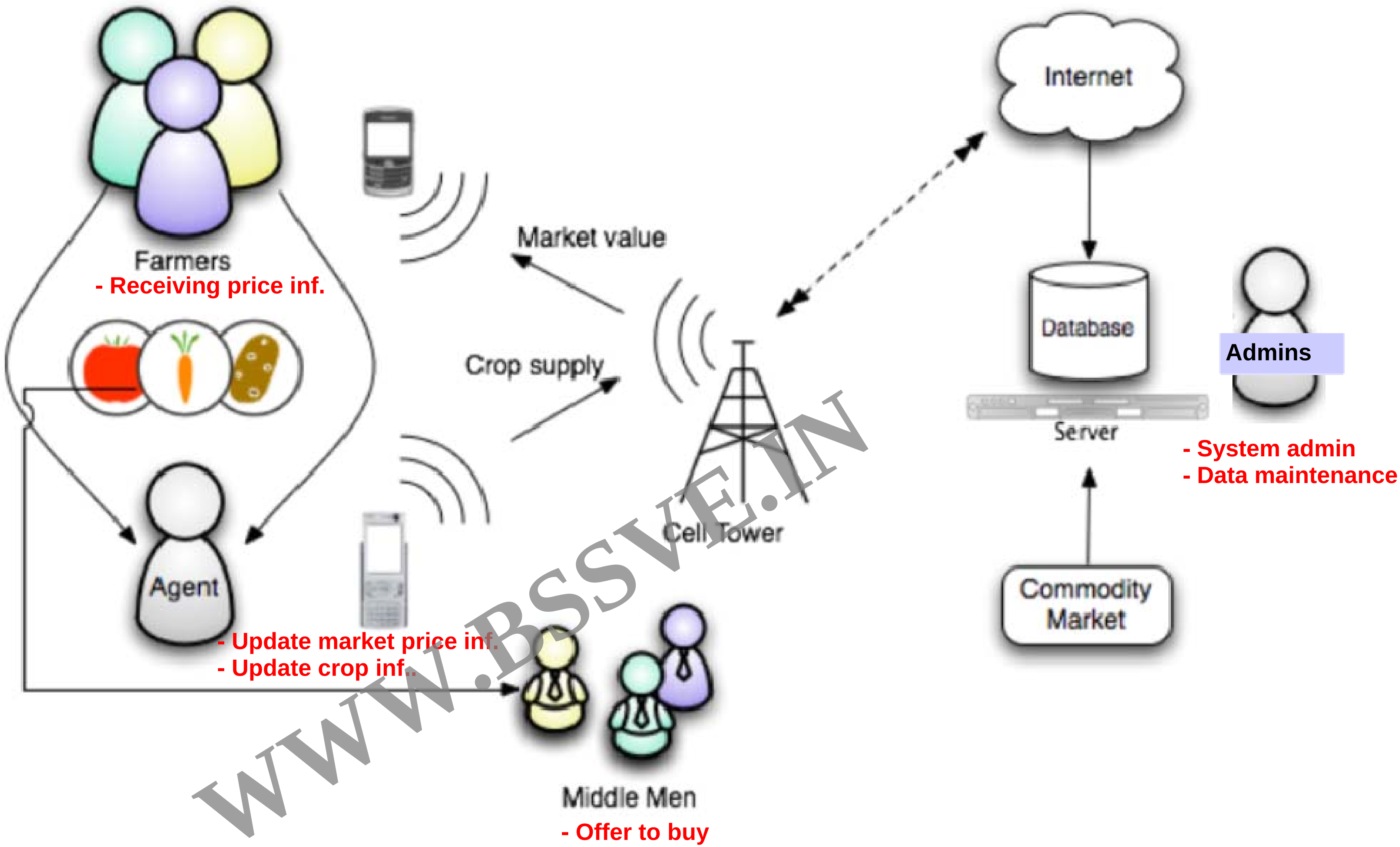
Milestone #4

System Review



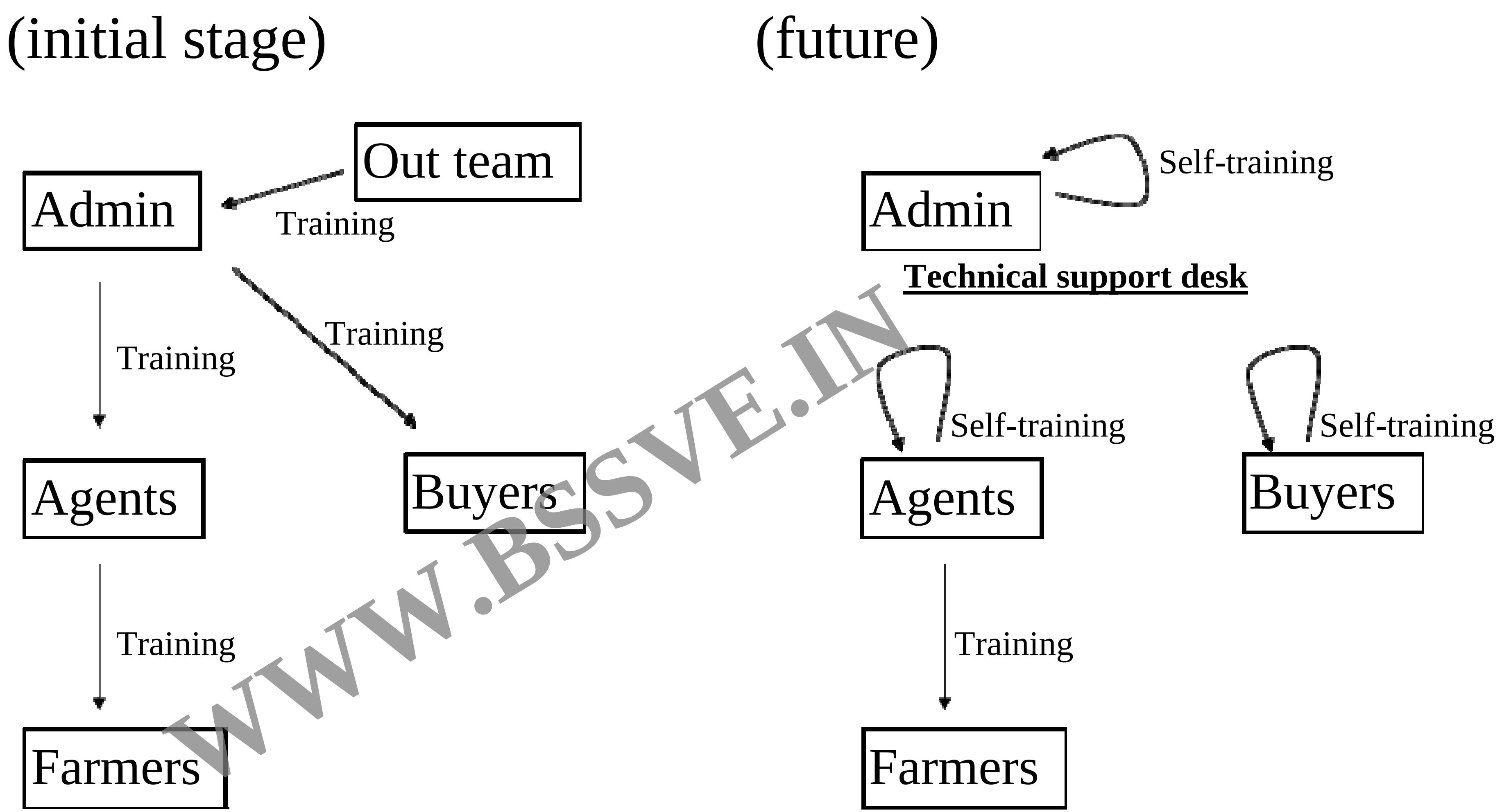
Sustainability Overview

- Human Resources
  - (initial stage) Managed by our team & partner
  - (future) Independent as NPO
- Technology
  - (initial stage) Training by our staff
  - (future) Self-training and apprenticeship
- Operational
  - Incorporate farmers from current trials
- Financial
  - (initial stage) Financial support from banks
  - (future) Continuous investment by farmers

Human Sustainability

- Project Managers
  - (initial stage) Our team & partner
  - (future) Employed managers
- Administrators
  - (initial stage) Our team & ITESM students
  - (future) Employed technicians
- Agents
  - Local village leaders
  - Liaison between project and government
- Farmers
  - Farmers
- Buyers
  - (initial stage) Existing middlemen
  - (future) Existing middleman and whole sellers / retailers

Technological Sustainability



Financial Sustainability (1)

(initial stage)

- Income
  - Support from Gov
- Outcome
  - PC, Cell phones
  - Other equipments
  - Software development (incl. documentation)

(future)

- Income
  - Commission fee from farmers
  - Support from Gov
- Outcome
  - Operating costs
  - Labor costs
  - Continuous investment

Financial Sustainability (2)

(US$)	**(initial stage)**	**a FY (in future)**	
IN	**15,000**	**80,000**	
1. Support from Gov (or ITESM	15,000	20,000	(Covering operating/management cost)
2. Commission fee	0	60,000	($2,000/yr from each community)
OUT	**15,000**	**77,400**	
Investment	*15,000*	*4,700*	
1. Server, PC, Cell phone	10,000	4,000	(Total value $20,000, 5 yrs life)
2. Other equipments	5,000	700	(7 yrs life)
Operating/Management cost	*0*	*15,700*	
1. Office rent	0	10,000	(Studio size office - less than $1,000/mon)
2. Communication charges	0	900	(Broadband $75/mon)
3. Lighting, Heating, etc.	0	2,400	($200/mon)
4. Others	0	2,400	($200/mon)
Labor cost	*0*	*57,000*	
1. Manager	0	16,000	($16,000/yr)
2. Technical staff	0	16,000	($16,000/yr)
3. Local Agents	0	25,000	($500/yr * 30 communities)
TOTAL	**0**	**2,600**	

Assume that annual income of a farmer family improves from $2,000/yr to $4,000/yr. If there are 20 families in a community, a family pays $100/yr for this project. (**5% of income improvement**)

Qs/Cs?

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Fall 2008

Photo of some Telmex Fellows removed due to copyright restrictions.

The Fellows Forum

Team Advisor:

Andrés Monroy-Hernández

Telmex Contact:

Marco Escobedo

Jonathan Varsanik

Brian Moore

Julianne Palazzo

& two anonymous MIT students

nextlab

December 10, 2008

What is the fellows forum?

- Web and mobile technology based network
- Promotes academic and professional development
- Medium for exchanging ideas, finding career and professional advice, and connecting with peers
- Gateway for students to pursue ambitions inside and outside of school

nextlab

the fellows forum

Context

- Telmex Fellows
  - 10,000 students from low-income areas with excellent academic records
  - Enrolled in colleges throughout Mexico
  - Receive stipend, computer, and net access
  - Huge potential to impact social development of their communities

How do we help these students realize the value that they can generate together?

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the fellows forum

Solutions

Current Solution:
www.interactuando.org

- Bias towards social networking
- Underutilized
- Lack of focus

Image removed due to copyright restrictions.
Screenshot of http://www.interactuando.org.

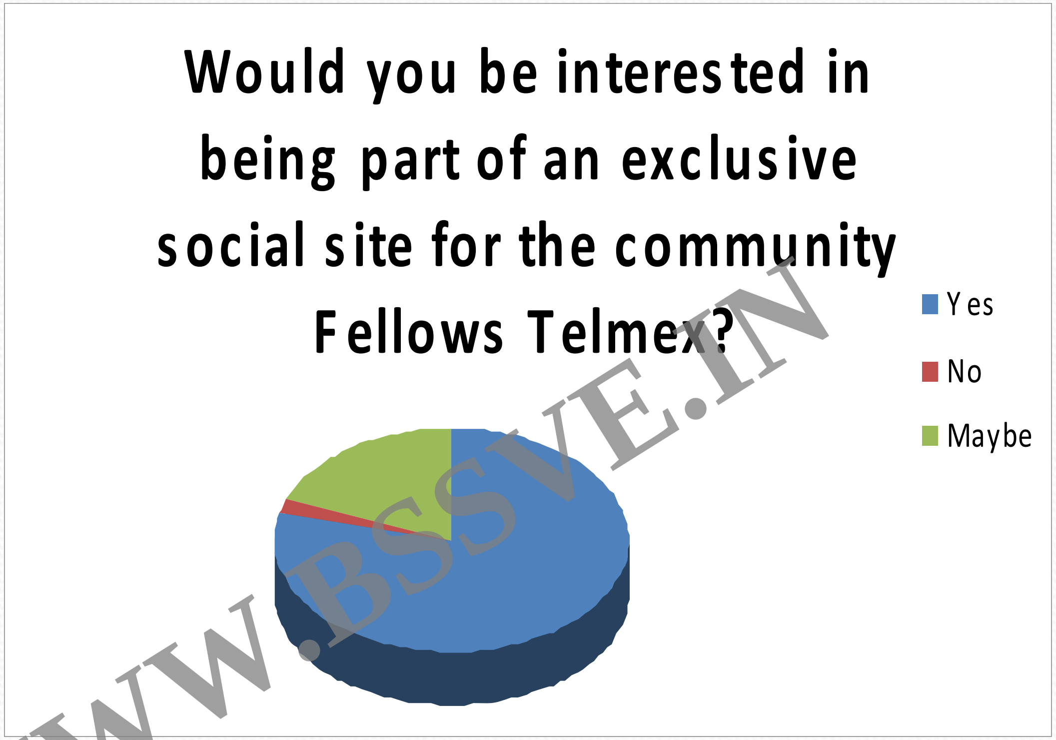
Needs Assessment

How do we refine the existing solution?

- Conducted survey to inquire about internet use and mobile use
- Approx 1300 responses gathered
- Audio conference

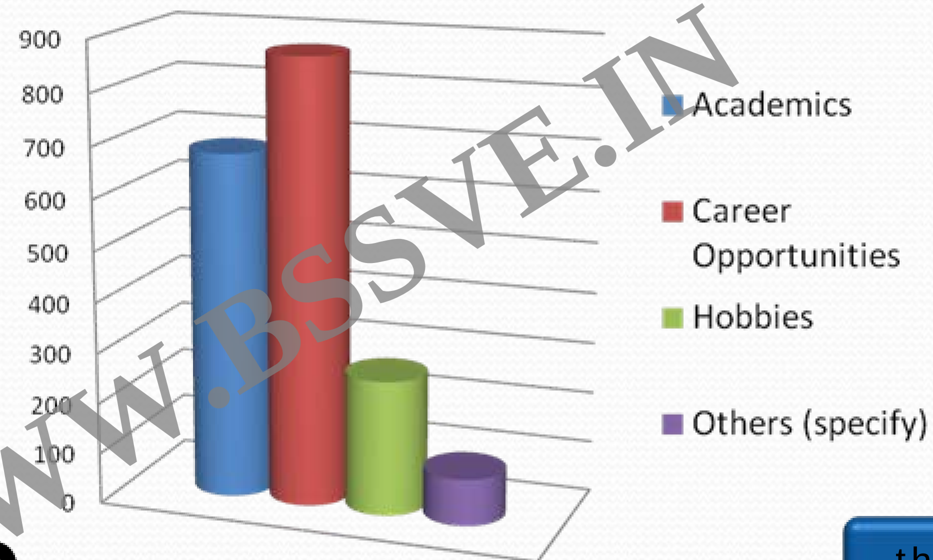
Needs Assessment

- Results
  - Agreement on desire to have exclusivity



Needs Assessment

- Results
  - Agreement on desire to have exclusivity
  - Academic and professional advice over social connection



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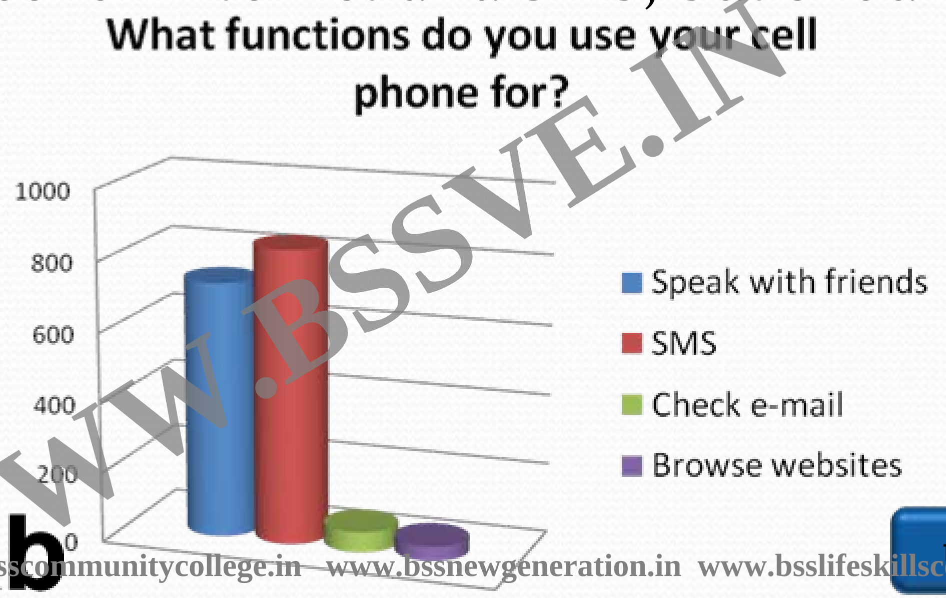
Needs Assessment

- Results
  - Agreement on desire to have exclusivity
  - Academic and professional advice over social connection
  - Preference for internet and SMS, but should be low cost



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Needs Assessment

- Results
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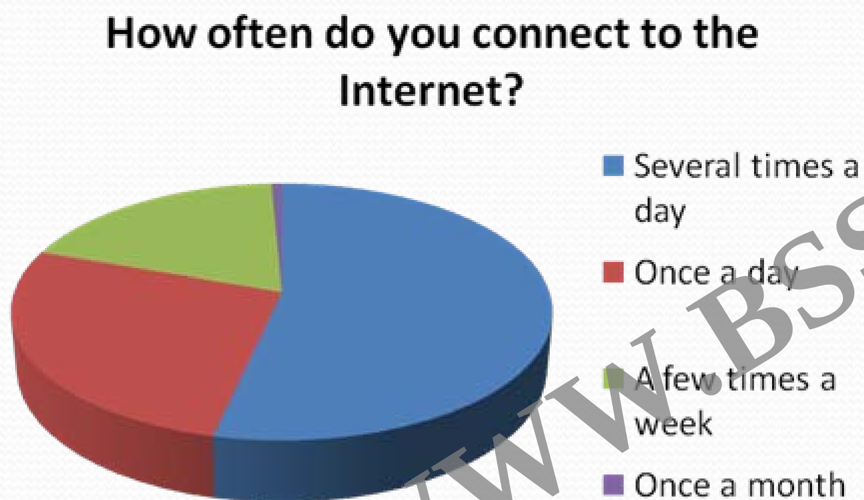

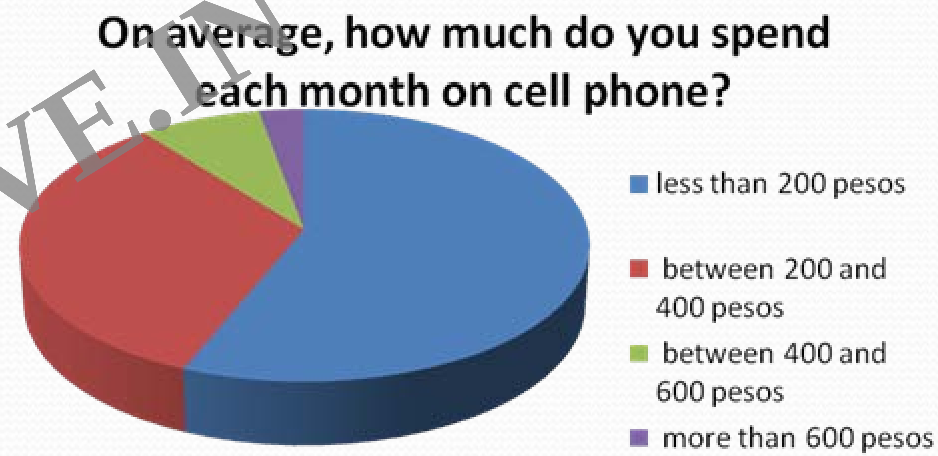

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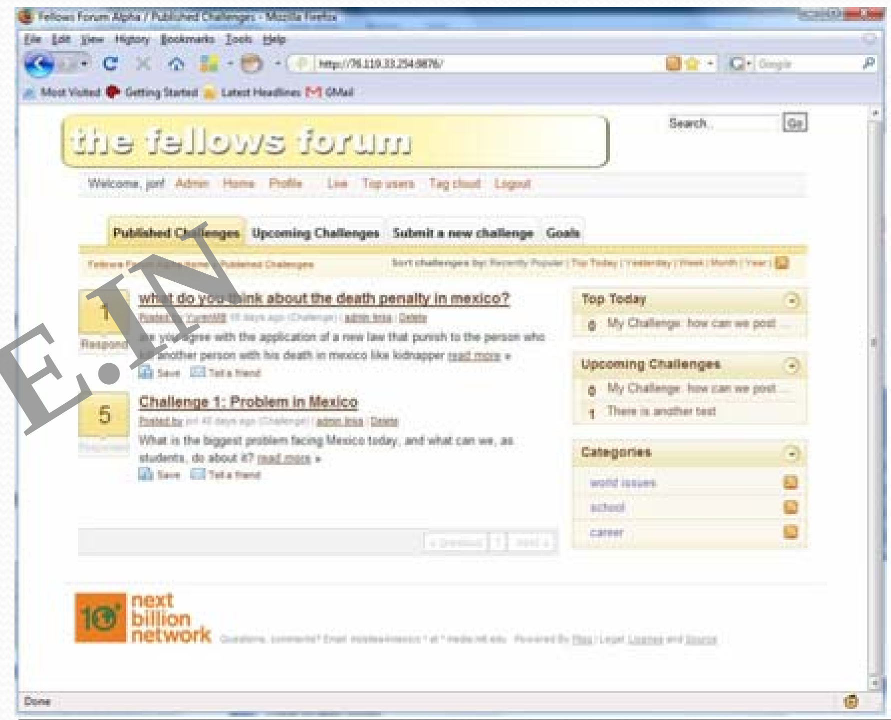
Our Solution

- Online (and mobile) network to foster lasting connections and motivation among students.
- Network has two main activities for the students:
  - Posting and responding to Challenges
    - Open-ended questions that are chosen to promote discussion
  - Sharing Goals
    - Post career goals on personal profile
    - Get feedback from peers and alumni



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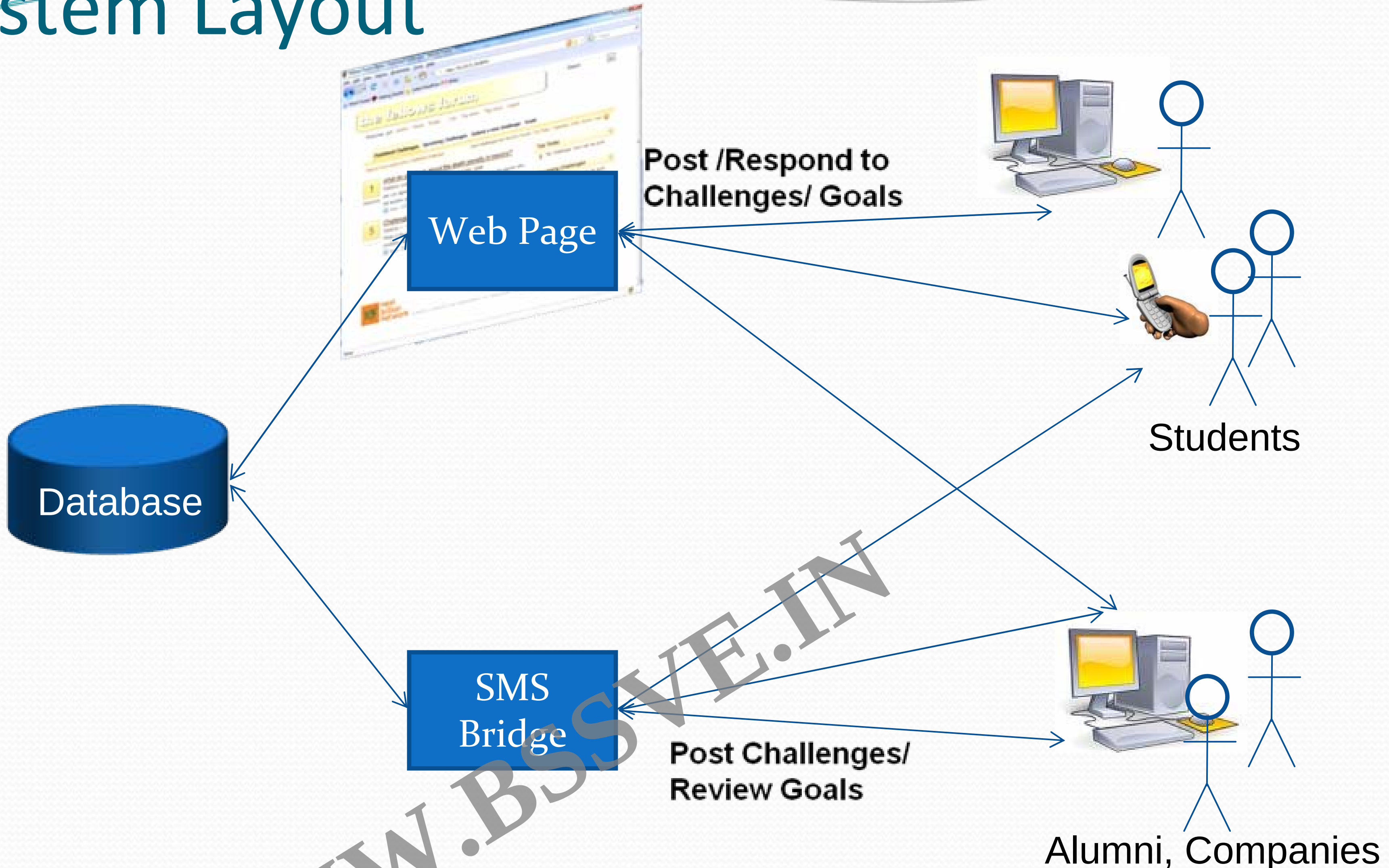
System Layout



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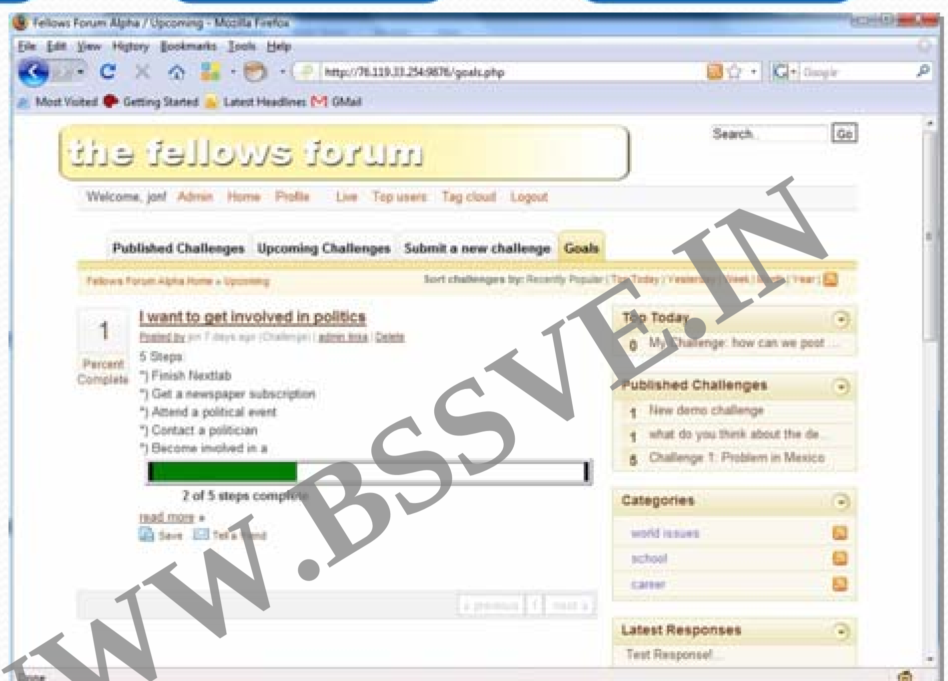
Usage scenario 1: Sharing Goals

Fellow posts career goals on profile → Goals are reviewed by alumni, given intermediate steps → Fellows report progress on steps → Fellow gets "points" for completed steps



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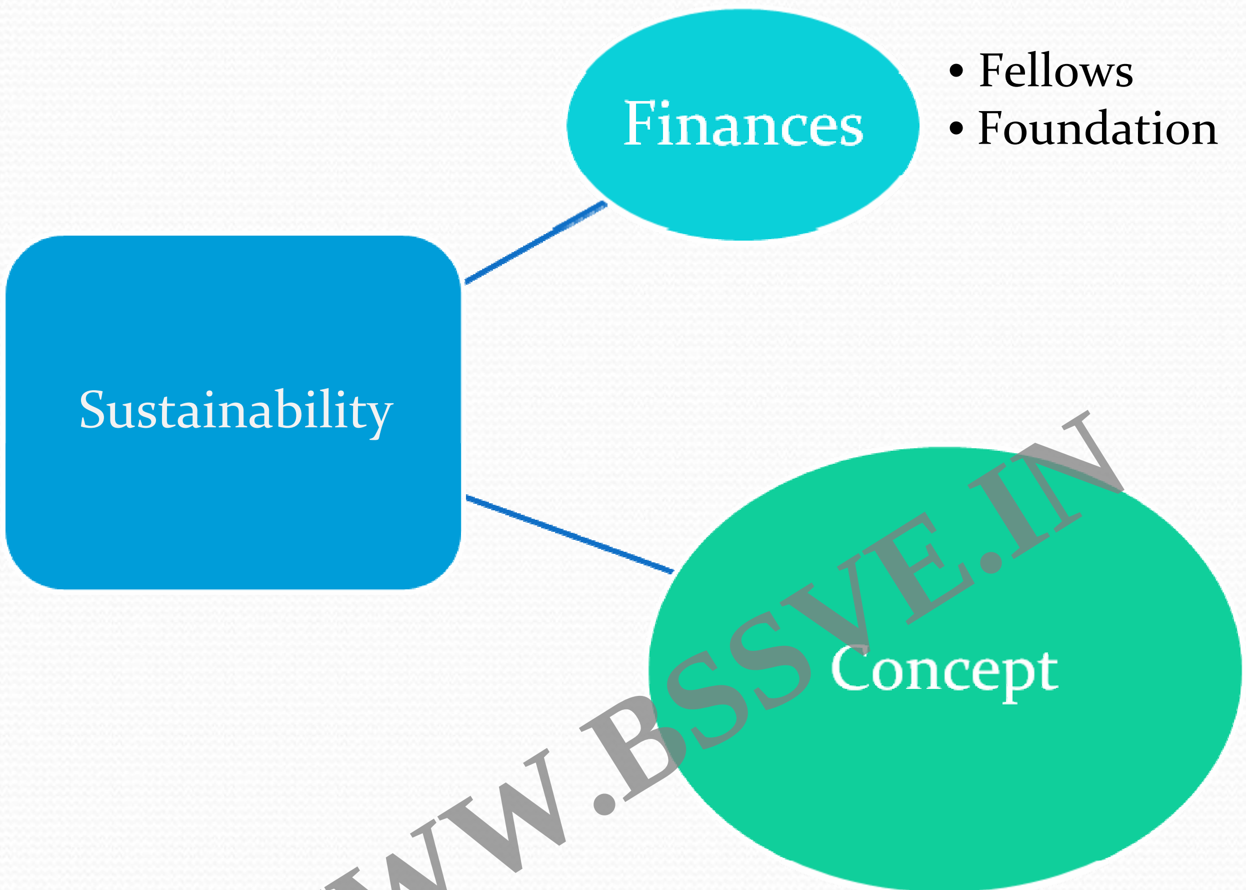
Usage Scenario II: Challenges

Demo

Sustainability



- Fellows
- Foundation

- Fellows
- Foundation

Sustaining the Costs

- Operational Costs
  - server management
  - labor for website
- Student Costs
  - local cost for SMS
- Generating Revenue
  - advertising on website
  - companies paying to be members of network
  - companies post challenges

Sustaining the Concept

FELLOWS:

- Appeal of "Challenges"
- Website aesthetics and functions align with student preferences
- Create exclusivity and sense of community

FOUNDATION:

- Ensure fresh content
- Transitioning: independent committee to handle the network
- Building status and reputation; furthering scholarship

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the fellows forum

Conclusions from our work

Developed a possible structure for networking:

- Encourage participation of group members
- Encourage planning for future

Testing Prototype…

Open questions:

- SMS component
- Incentivization
- Success?

Future Outlook

- Metrics for Success
  - Usage: number and speed of responses / users
  - Focus group feedback
  - Attendance at other Telmex Foundation events

- Applicability
  - This can be used for any environment that calls for a unique, productive way to connect its members
    - Especially those looking for academic/professional discussions
  - Universities
    - Programs within a university (i.e.: MITES program)
  - Scholarship/Fellowship Programs

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Acknowledgements

- Telmex Foundation
  - Marco Escobedo

- MIT NextLab
  - Course Intructors: Jhonatan Rotberg
    Luis Sarmenta
  - Course TA: Paul J.H. Yang
  - Project Advisor: Andrés Monroy-Hernández

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Fall 2008

TelmexConnect:

Mobile(?) social network for low-income students

Jonathan Varsanik (MIT)

and two anonymous MIT students

Brian Moore (Emerson)

Julianne Palazzo (Emerson)

Nextlab Fall 2008
Milestone #1

The pitch

"TelmexConnect" is a network for linking Telmex Foundation Fellows, both professionally and socially. TelmexConnect will be a medium for them to exchange ideas, collaborate on projects, find career and professional advice, and effectively reach more of their peers. The network will encourage these students to motivate each other and obtain resources to pursue their ambitions both inside and outside of school using web and mobile technologies.

Background

- Telmex Fellows
  - 10,000 students from low-income areas with excellent academic records
  - Enrolled in colleges throughout Mexico
  - Receive stipend, computer, and net access
  - Huge potential to impact social development of their communities
- How to realize the value that they can generate together?

Existing Solution:
interactuando.org

Image removed due to copyright restrictions.
Screenshot of http://www.interactuando.org.

- Too broad?
- Confusing?
- Useful?
- Used by anyone?

Similar Solution

Image removed due to copyright restrictions.

Screenshot of webpage for Gates Millenium Scholars - Scholar Connection.

- Is this what we want?

Related Solutions: Social

- Can this do it?

Image removed due to copyright restrictions.
Screenshot of webpage for Facebook.

Related Solutions: Professional

Image removed due to copyright restrictions. Screenshot of webpage for LinkedIn.

Related Solutions: Interest

Image removed due to copyright restrictions. Screenshot of webpage for civilrights.org Student Activity Network.

Related Solutions: Interest

Image removed due to copyright restrictions. Screenshot of webpage for Carolina Student Biotechnology Network.

Mobile?

Related Solutions: Answers

Image removed due to copyright restrictions. Screenshot of webpage for Mosio.

Related Solutions: Mobile Connections

Image removed due to copyright restrictions. Screenshot of webpage for JYGY.

Open questions

- Why will students use the network?
  - What will they get from it?
  - What will they generate?
- Can/should we break away from the facebook model?
- How can / should we incorporate mobile devices?

Solutions

- Conceptual solution first priority
  - Making interactuando.org more user-friendly. Create a direction for the website. Will this suffice?
  - Incorporate mobile technology to get more hits to website.
- Create incentive system where the direct incentive is mobile minutes
- Involve current fellows in actively improving the networking system themselves

Questions?

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Fall 2008

TelmexConnect Milestone #2

Team:

Jonathan Varsanik

& two anonymous MIT students

Julianne Palazzo

Brian Moore

Some related solutions…

Social: Facebook

Professional: LinkedIn

Screenshots of webpages removed due to copyright restrictions.

Academic: Gates Millenium Scholars "Scholar Connection"

Interest Based: civilrights.org "Student Activist Network"

Needs Assessment (Why?)

- Optimize the existing solution?
- Introduce a mobile network?
- What is the lack the Fellows perceive?
- What are their expectations?
- Feedback from our project partner (Telmex)

Our Needs Assessment Strategy

- Discussion with project partner
- Disseminate a survey to around 200 Fellows
- Collaborate with a focus group

Survey:

- Multiple revisions to arrive at an optimum number of questions ,effectively framed
- Translated to Spanish (multiple reviews)
- 200 Fellows selected by project partner
- Measures taken to make sure the group has a mix of Fellows who are active members of Interactuando.org as well as those who are not
- Distributed online via Surveymonkey

The Survey!

Survey for Telmex Fellows

Hello! Congrats on being a recipient of the Telmex Foundation Sc
would like to learn from you about your experiences as Fellows of
individuals. We would like to use your valuable feedback/suggesti
Telmex Fellows' Community! We request you to take a few minu
questions.

BASIC INFO

Age _____

Gender ______

City ___________

What is your area of study? ____________________

What are your hobbies? ____________________

Telmex Foundation Feedback

1. How many Telmex Fellows within your University do you kno
choose one option)
   a) less than 10
   b) 10-30
   c) 30-50
   d) greater than 50 (please mention an approximate number ____

2. How many Telmex Fellows do you know or collaborate with ou
choose one option)
   a) less than 10
   b) 10-30
   c) 30-50
   d) greater than 50 (please mention an approximate number ____

3. What social networking sites are you currently a member of? *(T
options)*
   a) Hi5
   b) Metroflog
   c) Facebook
   d) MySpace
   e) Others *(please specify)* ____________________

4. a) Are you a member of Interactuando.org?
   - Yes
   - No

10. How do you keep in touch with your friends?

	Most often	Sometimes	Rarely	Never
Email				
Phone calls				
SMS				
Social networking website				
Meeting in person				

11. What do you use your personal mobile phone for?

	Most often	Sometimes	Rarely	Never
Calling friends				
SMS				
Checking email/web browsing				

___ I don't use a mobile phone

12. On an average, how much do you spend each month as mobile phone charges?

____

13. If you were given a chance to connect via SMS with 10,000 Telmex Fellows, what would you most likely say? :)

____

Thank you! We may need further feedback from you, which is entirely optional, if you would like to be a part of our study please provide us an email id __________

networking sites?
- Yes
- No
- Maybe

Massachusetts Institute of Technology

Project: Telmex Connect

The survey in Spanish

9. ¿Qué tan útil te sería si pudieras entrar en contacto con otros becarios Telmex para colaborar y discutir sobre temas relevantes como:

	Muy relevante/útil	Algo relevante	No estoy seguro	Para nada útil
Temas académicos				
Oportunidades de empleo				
Hobbies				
Otros (especificar)				

10. ¿Estarías interesado en formar parte de un sitio social exclusivo para la comunidad de Becarios Telmex?

- Si
- No
- Tal vez

11. Si tu respuesta fue SI, ¿preferirías que este sitio estuviera ligado a tus cuentas actuales en otros sitios de redes sociales?

- Si
- No
- Tal vez

12. ¿Cómo te mantienes en contacto con tus amigos?

	Regularmente	Algunas veces	Raras ocasiones	Nunca
Email				

Survey: Typical questions

Do they connect with Telmex Fellows within/outside their universities?

How do they connect with Telmex Fellows?

Awareness of the existing website

4 a) Are you a member of Interactuando.org?
Yes
No
b) If Yes, how often do you use Interactuando.org?
Everyday
At least once per week
A few times each month
Never

Is there a perceived need for more interaction among Fellows

8. How useful would it be if you could connect and collaborate with other Telmex Fellows to discuss common issues like:
(please check appropriate boxes)

	Very useful	Somewhat useful	Not sure	Not at all useful
Academics				
Career Opportunities				
Hobbies				

Survey: Typical questions

Level of mobile/internet usage

-how often do they access internet/from where?

-mobile phone primarily used for (SMS/ voice calls/browsing)

How do the Fellows currently network

3. What social networking sites are you currently a member of?
(You may choose multiple options)
a) Hi5
b) Metroflog
c) Facebook
d) MySpace

e) Others *(please specify)* ___________________________

Massachusetts Institute of Technology

Project: Telmex Connect

Salient points from discussion with project partner

- Around 5000 Fellows currently registered on the website

-it is mandatory for them to register during their tenure as Fellows

- "Interactuando.org" was intended to be an open space for academic collaboration and social networking.

-the community of Fellows isn't very clear about this

-presently the website is more directed towards social networking

Discussion with project partner

- A new solution should focus more on collaboration at the **academic** and **professional** level

-create knowledge within the community

-encourage mentoring

- Our proposed incentive based system and ideas for establishing an academic/professional networking were found promising

Proposed two-level course of action

- **Increase activity on the website by:**

  throwing open competitions/challenges (would act as an incentive to use the website)

TelmexConnect :Click a Pic! Take a picture with as many Fellows, maybe with a Telmex sign in the field of view (would encourage them to meet)

Telmex Connect : Creative Answers!

- **Incentivize current members to encourage more Fellows to join the Telmex Connect network.**

Collaborate with a focus group

- Conversation with a group of 5-7 Fellows (*before the end of this week)*
- Make them feel a part of this team, learn about their ideas for better networking
- Would they be interested in connecting with other Telmex fellows for: career advice/academic help/goal-setting and leadership development ?
- Connect with former Fellows.
- Assess how useful the role of a mentor would be

Questions?

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Fall 2008

Fellows Forum Milestone 3

Two anonymous MIT students
Jonathan Varsanik
Brian Moore
Julianne Palazzo

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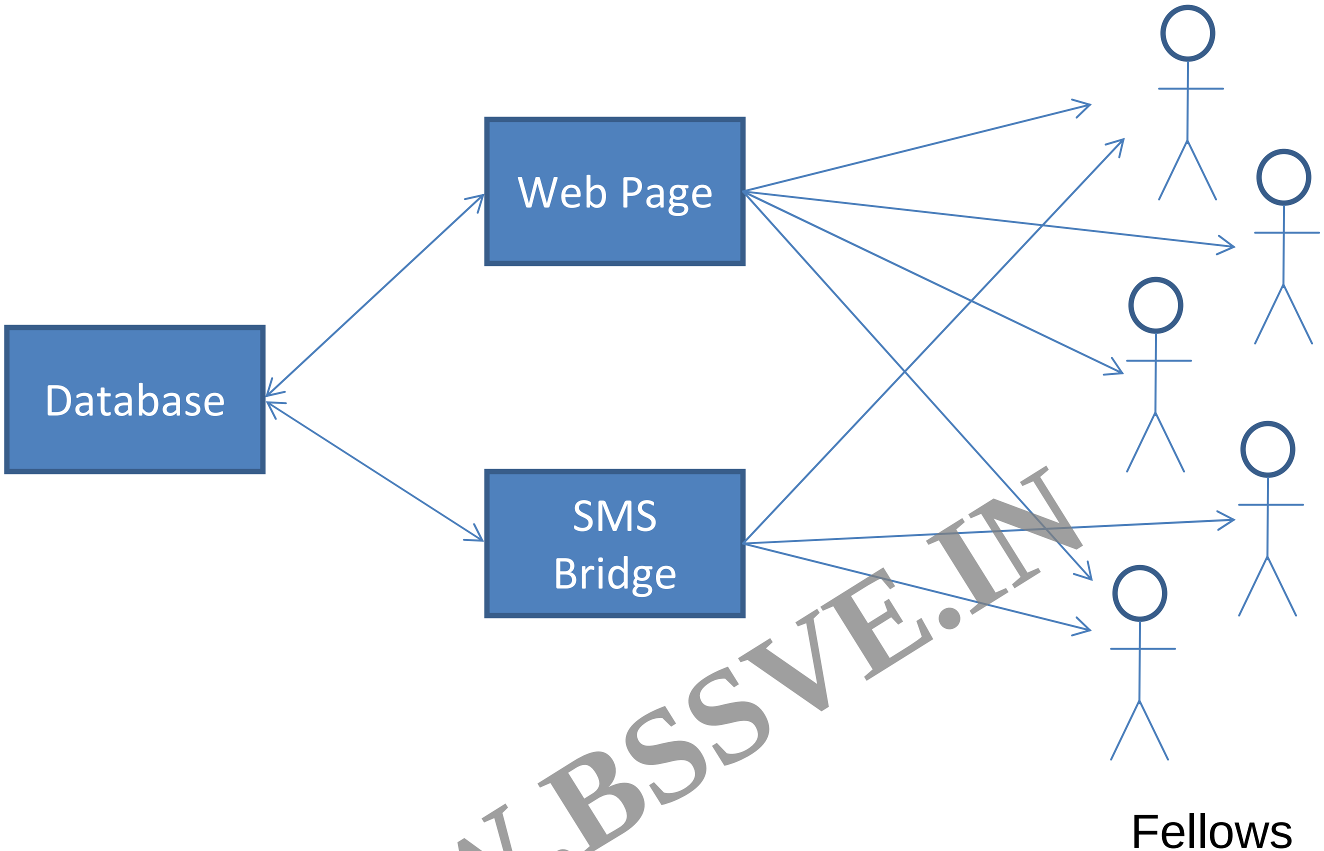
Fellows Forum

- Academic and career focused network
- Two Components
  - Challenges
    - Access via web and SMS
  - Goals
- Incentivize with "points" towards prizes

System Layout



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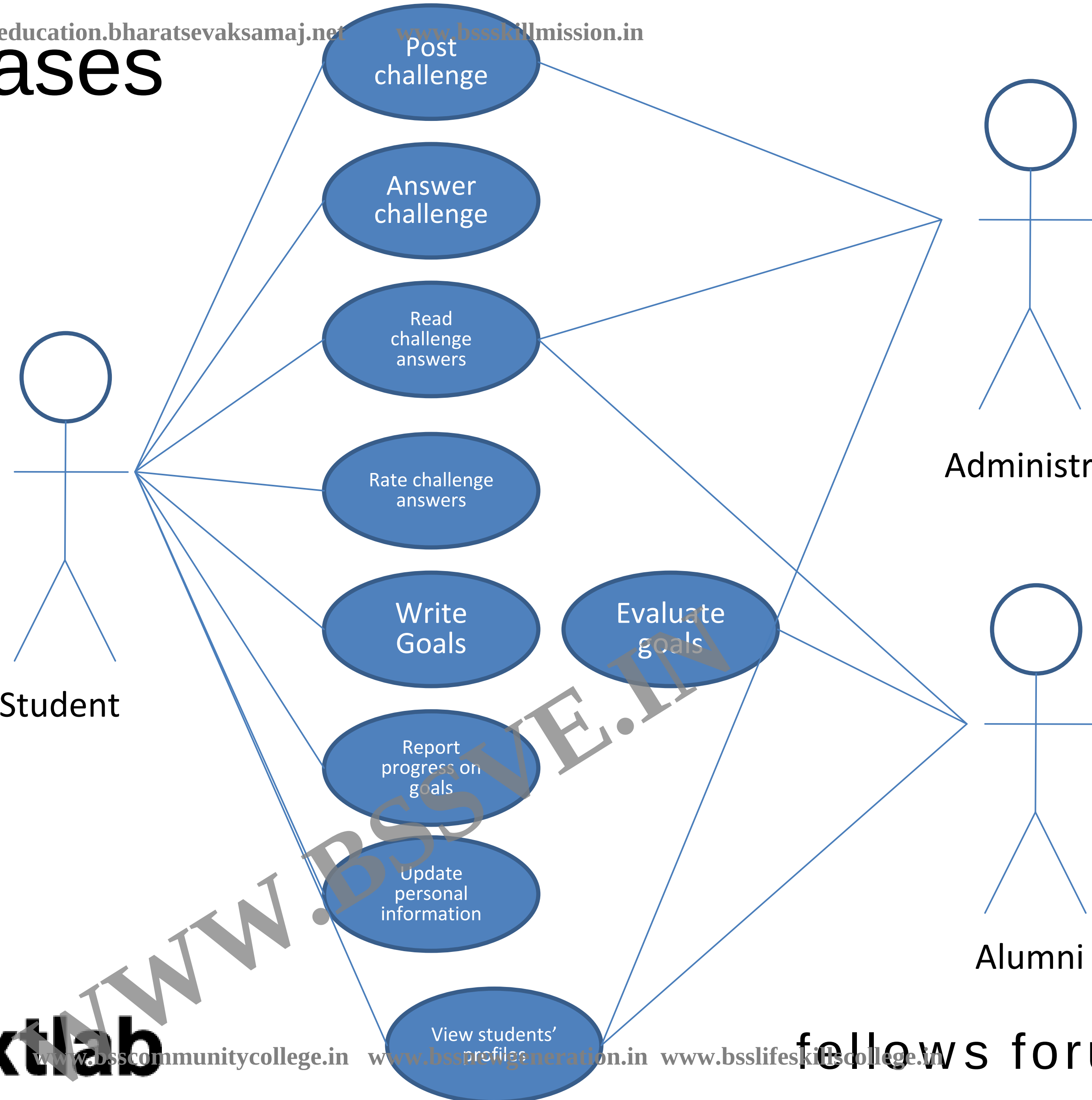
Use cases



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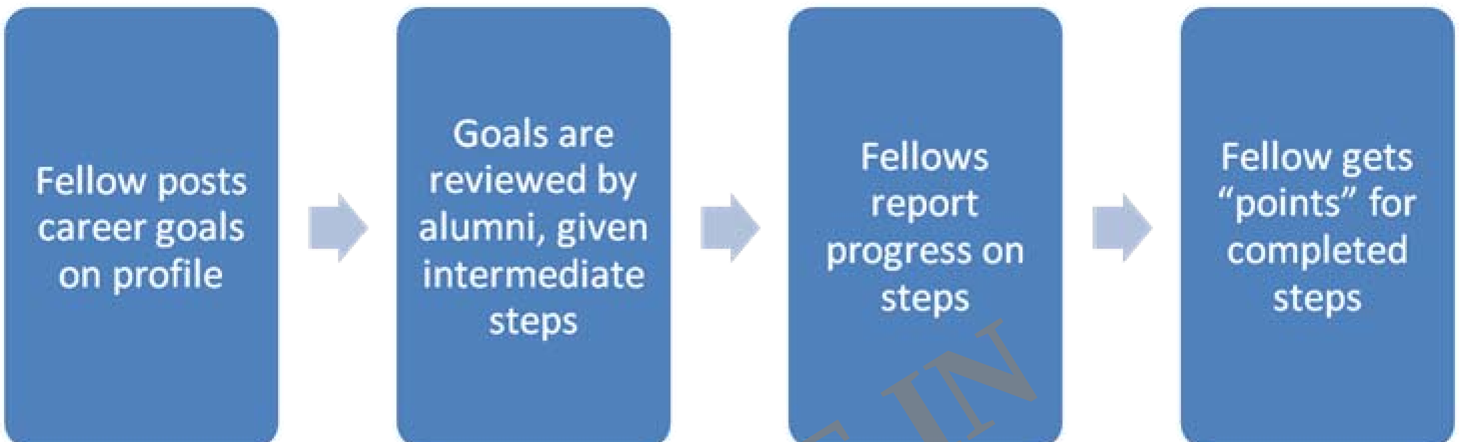
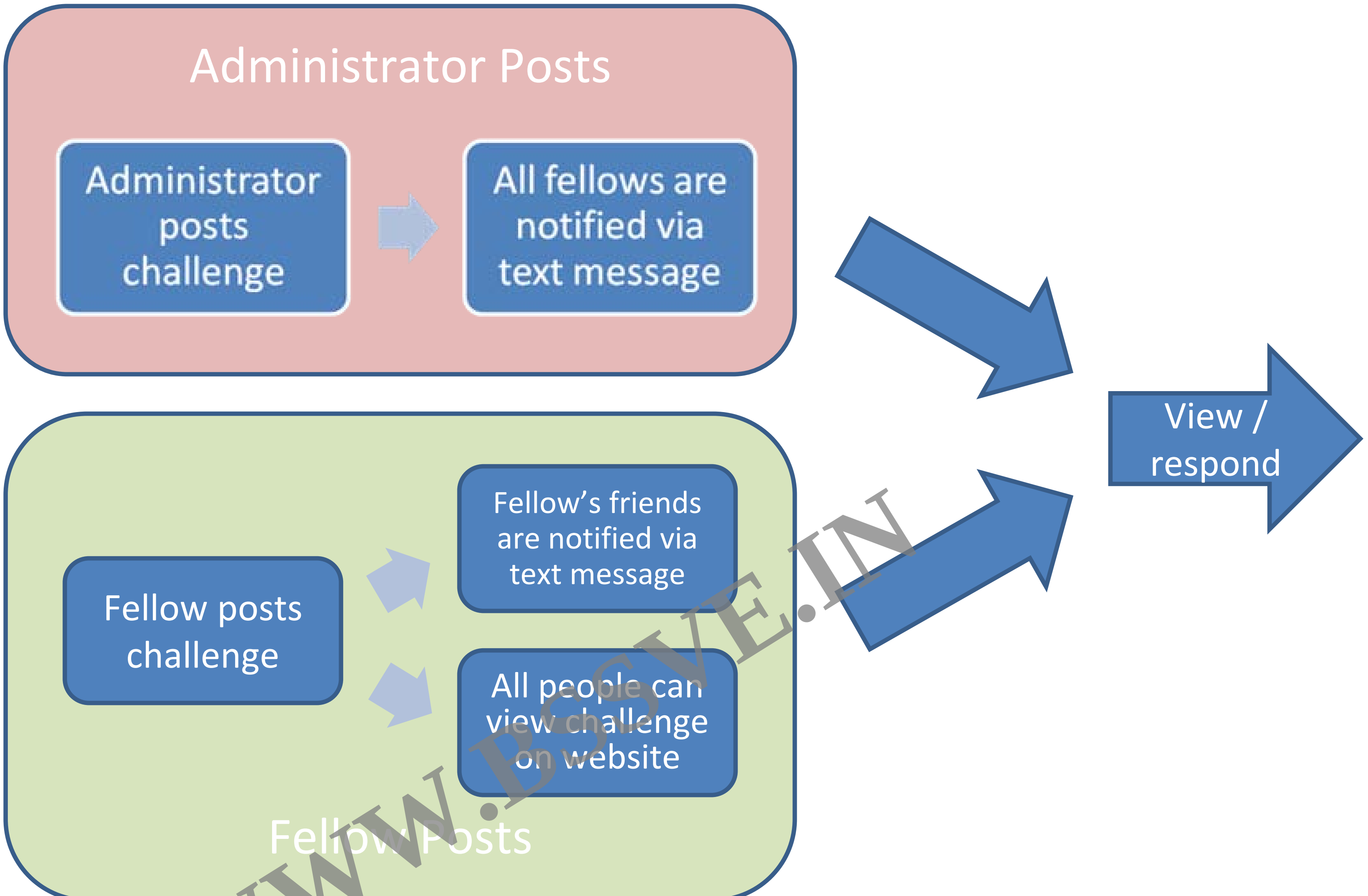
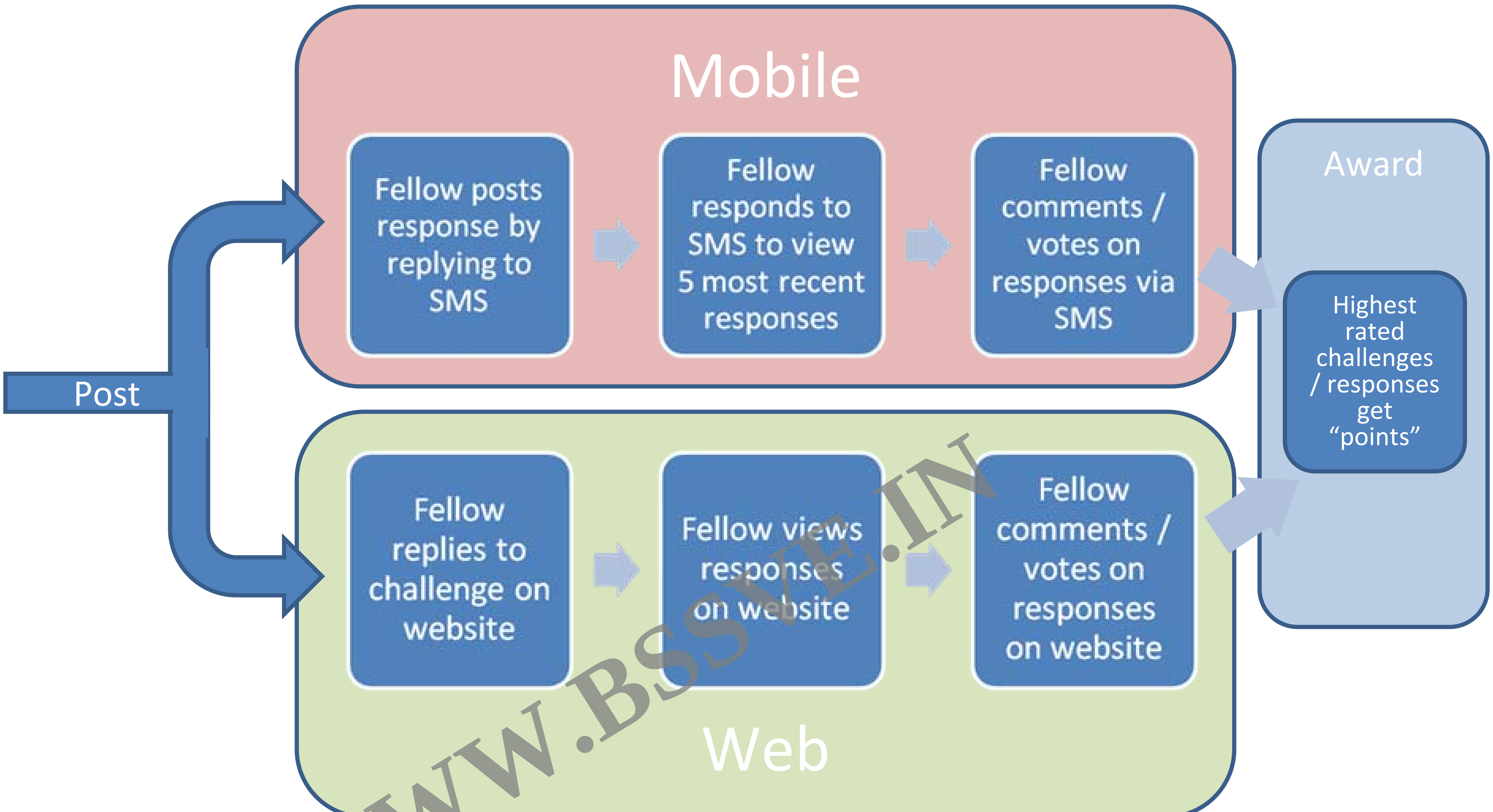
Usage scenario 1: Goals



Usage scenario 2: Challenges



Usage scenario 2: Challenges (2)



Timeline to completion

- This term
  - Website demo with SMS ability
  - Posting challenges on current website to initiate incentive structure
    - How accept responses?
- Future
  - All functionality moved to separate website

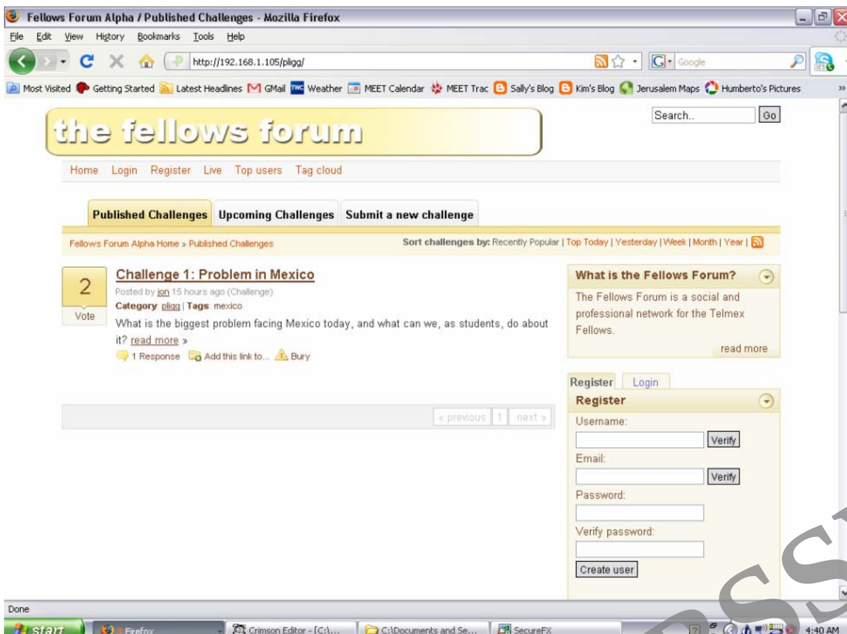
Difficulties

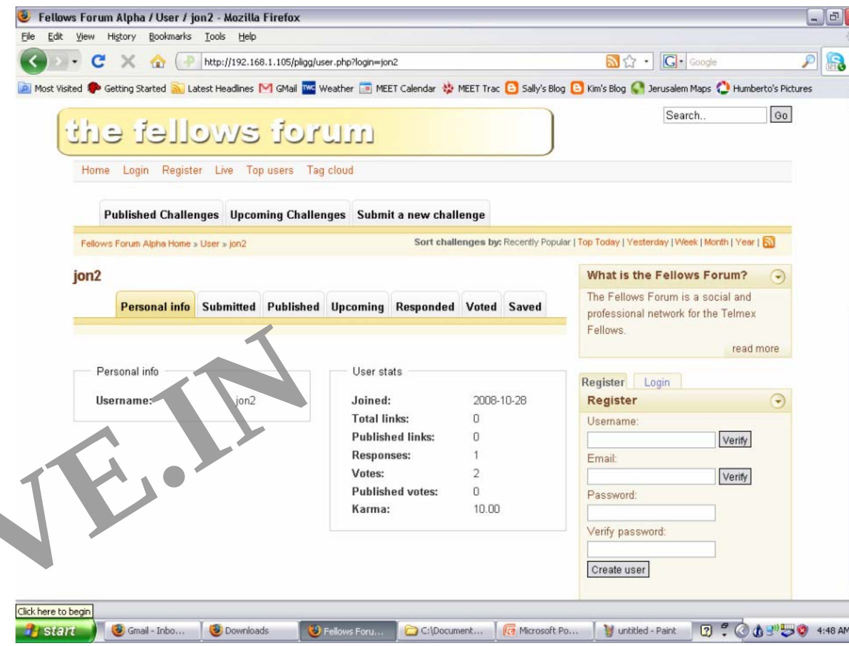
- Deployment
  - Integration of challenges with current website?
  - Ability to smoothly host challenges on another site?
  - Will either of these be able to have SMS integration?
- Will they use it
  - That will come from upcoming conversations / test challenges

Two Kinds of Prototype

- Technical
  - Website
  - SMS
- Social
  - Challenge attempt on current site

Challenge Website Demo





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Questions?

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Fall 2008

Fellows Forum

Milestone 4: Sustainability

Jonathan Varsanik
& two anonymous MIT students
Brian Moore
Julianne Palazzo

Fellows Forum

- Academic and career focused network
- Two Components
  - Challenges
    - Access via web and SMS
  - Goals
- Start with a prototype for focus group of fellows

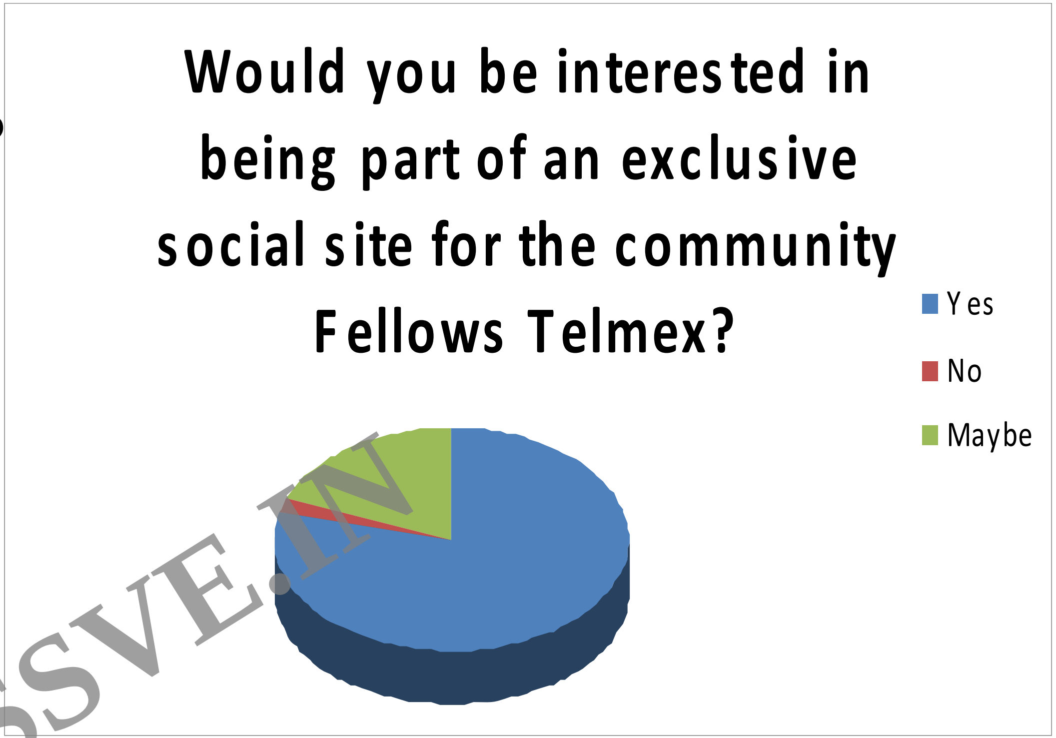
nextlab fellows forum

What does Sustainability mean for us?

Will our *concept* work for the Telmex community?

- Fellows
- Telmex Foundation

Our task is to make sure our blueprint improves the current networking climate



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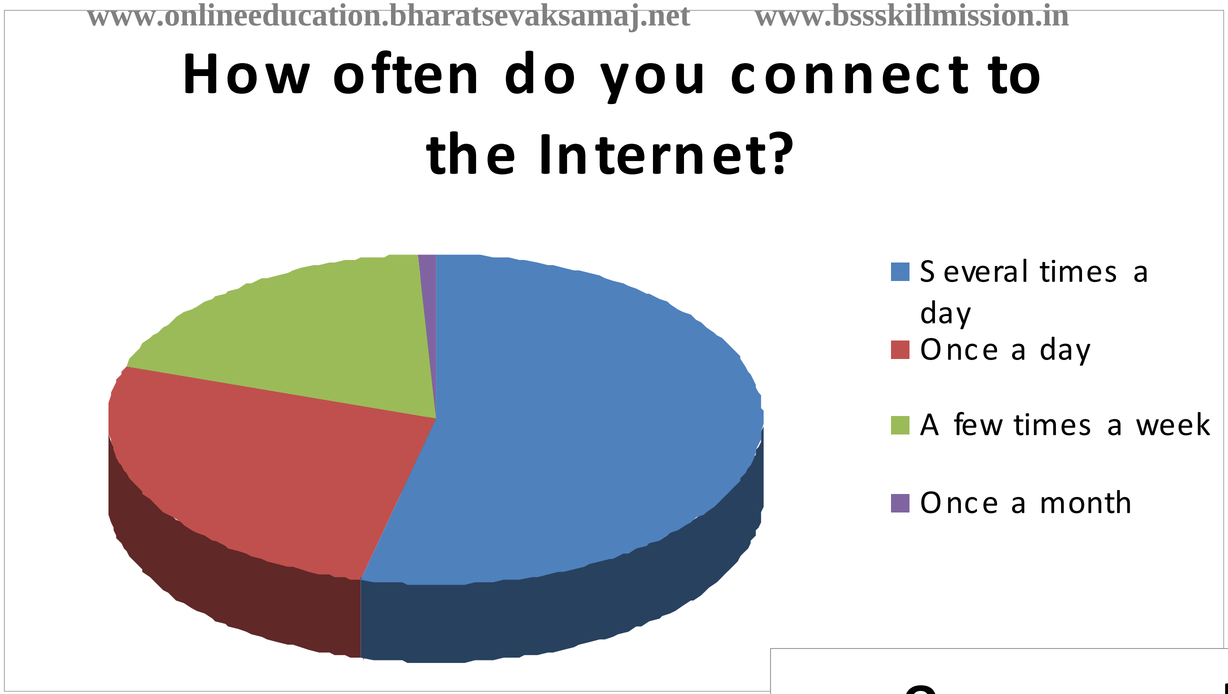
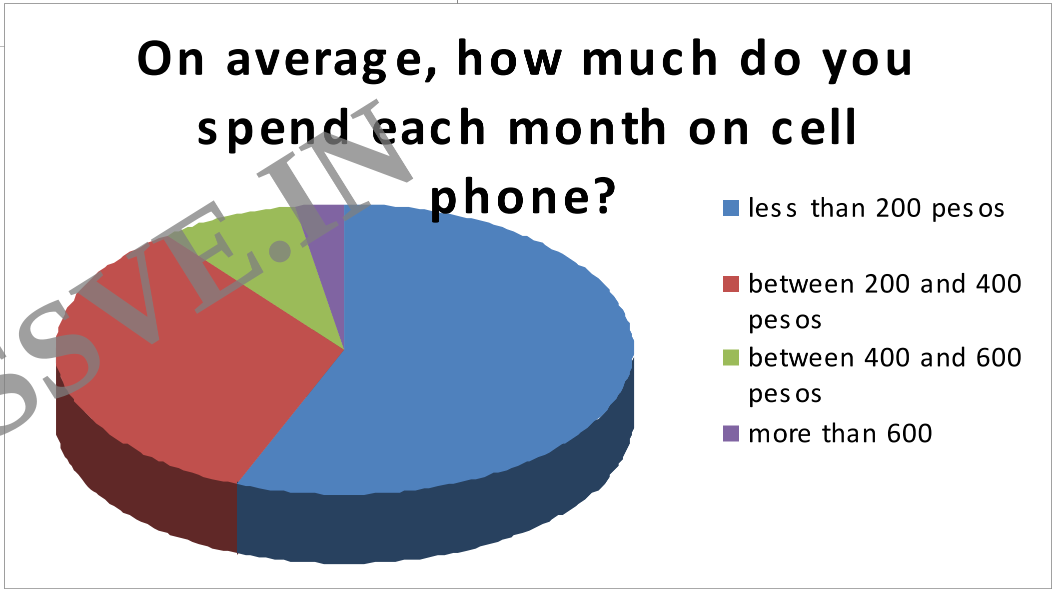

How often do you connect to the Internet?
Several times a day
Once a day
A few times a week
Once a month


On average, how much do you spend each month on cell phone?
less than 200 pesos
between 200 and 400 pesos
between 400 and 600 pesos
more than 600

Technology

- Components of Prototype:
  Website
  SMS Gateway
  Data management – Server
- Mostly working with off-the-shelf technologies, thus simple to understand
- **Fellows**: Will the SMS feature be used in conjunction with the website? This is something we will be testing.
- **Telmex Foundation**: Provide managers for server and website. Real problem comes with sustaining challenge.

Financial

- This is a service under an established foundation
- Operational Costs – server management, labor for interactuando.org plus our own website…covered by Telmex Foundation
- Student Costs – texting…is this viable?
  - Clickatell – commercial enterprise specializing in SMS gateway connectivity and bulk messaging services
- FUTURE – advertising on website to generate revenue; self-sustaining network?

Human

FELLOWS:

- Frequent conference calls
- Focus group will test our experimental prototype
- Focus group will critique elements of prototype
- Final test to entire community

Our concerns…

How are students responding to each trial?

How will we reduce apathy?

We want to make Telmex fellows feel that they are part of a special unit

Human

FOUNDATION:

- Issue of self-interest and image.
- Build partnership with Telmex so that it improves its status as a reputable scholarship organization
- Steady and continuous correspondence until all elements are in place

Our concerns…

Will the Foundation execute our plans?

How will our plan help the Foundation build its status?

Competition/Reputation

Future scholarships

Operational

- This Semester –
  1) Test out challenge both on website and through SMS with focus group
  2) Implement improved prototype to entire Telmex community and gage response
  3) Document response and level of interaction
  4) Does the idea work?

Operational

- For future NextLabbers and Telmex –
  1) If the idea works – make sure technology can be expanded and explained to Telmex
  2) Find ways to involve Alumni and incorporate Goals
  3) Transition entirely to separate website, local SMS gateway, and local servers
  4) Committee within Telmex to oversee social networking?

Questions?

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Fall 2008

UNITED VILLAGES
access for all

United Villages: M-Commerce Solutions

Anastasios Dimas
Michael Gordon
anonymous MIT student
Dev SenGupta

Emerson:
Kady Buchanan
Sarah Berkowich

United Villages:
Amir Hasson, CEO
Femi Omojola, CTO

Overview

- Our team is developing mobile solutions to increase supply chain efficiencies in the developing world.

Figures by MIT OpenCourseWare.

Overview

- Our team is developing mobile solutions to increase supply chain efficiencies in the developing world.

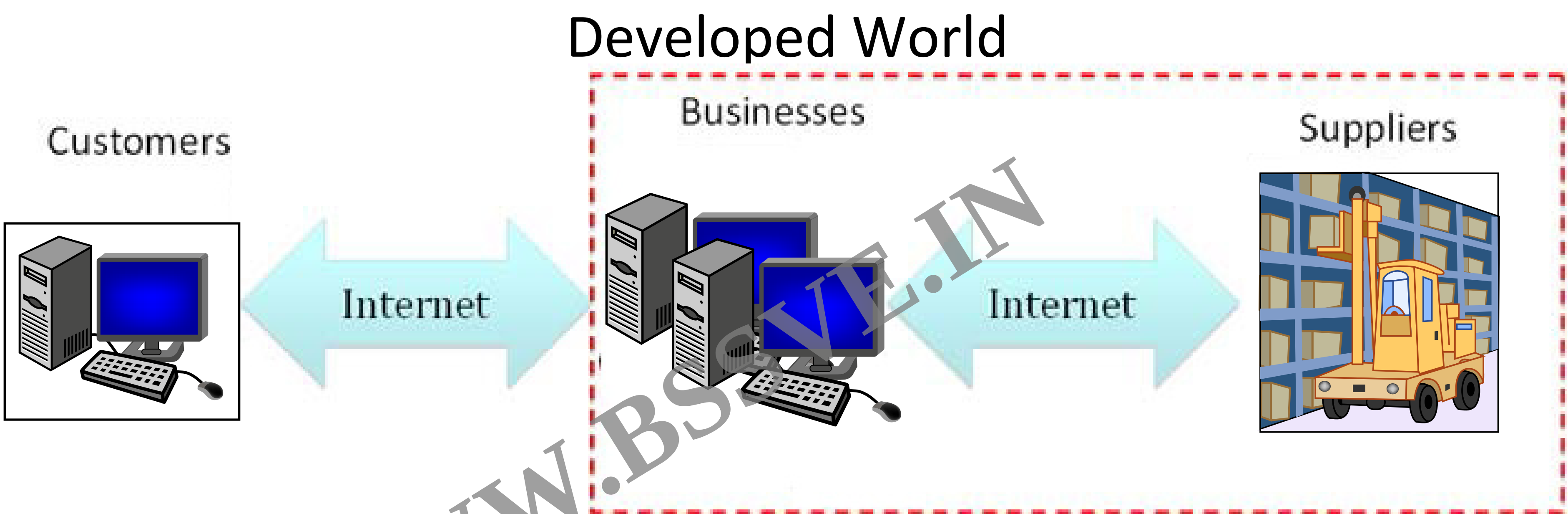
Developed World

Advantages:

- Business saves times
- Business can make more informed decisions
- Software solutions are scalable
- More choice for consumer
- Cheaper goods through competition and efficiency
- Anticipate market trends and supply problems
- Customer tracking and targeting

Overview

- Our team is developing mobile solutions to increase supply chain efficiencies in the developing world.

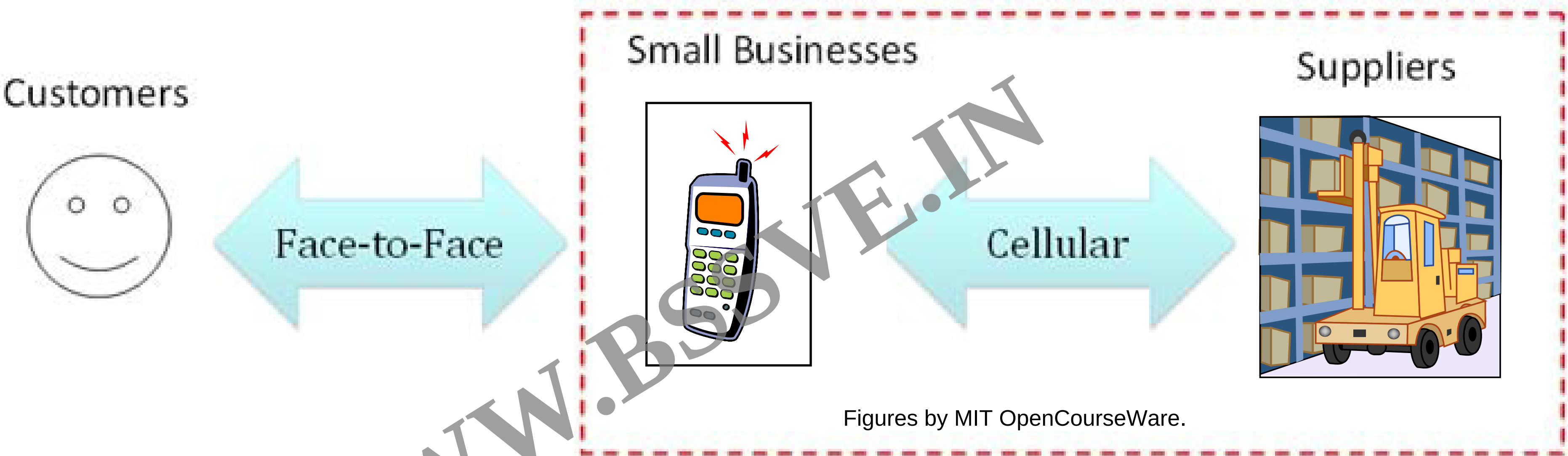


Figures by MIT OpenCourseWare.

Overview

- Our team is developing mobile solutions to increase supply chain efficiencies in the developing world.

Proposal for Developing World



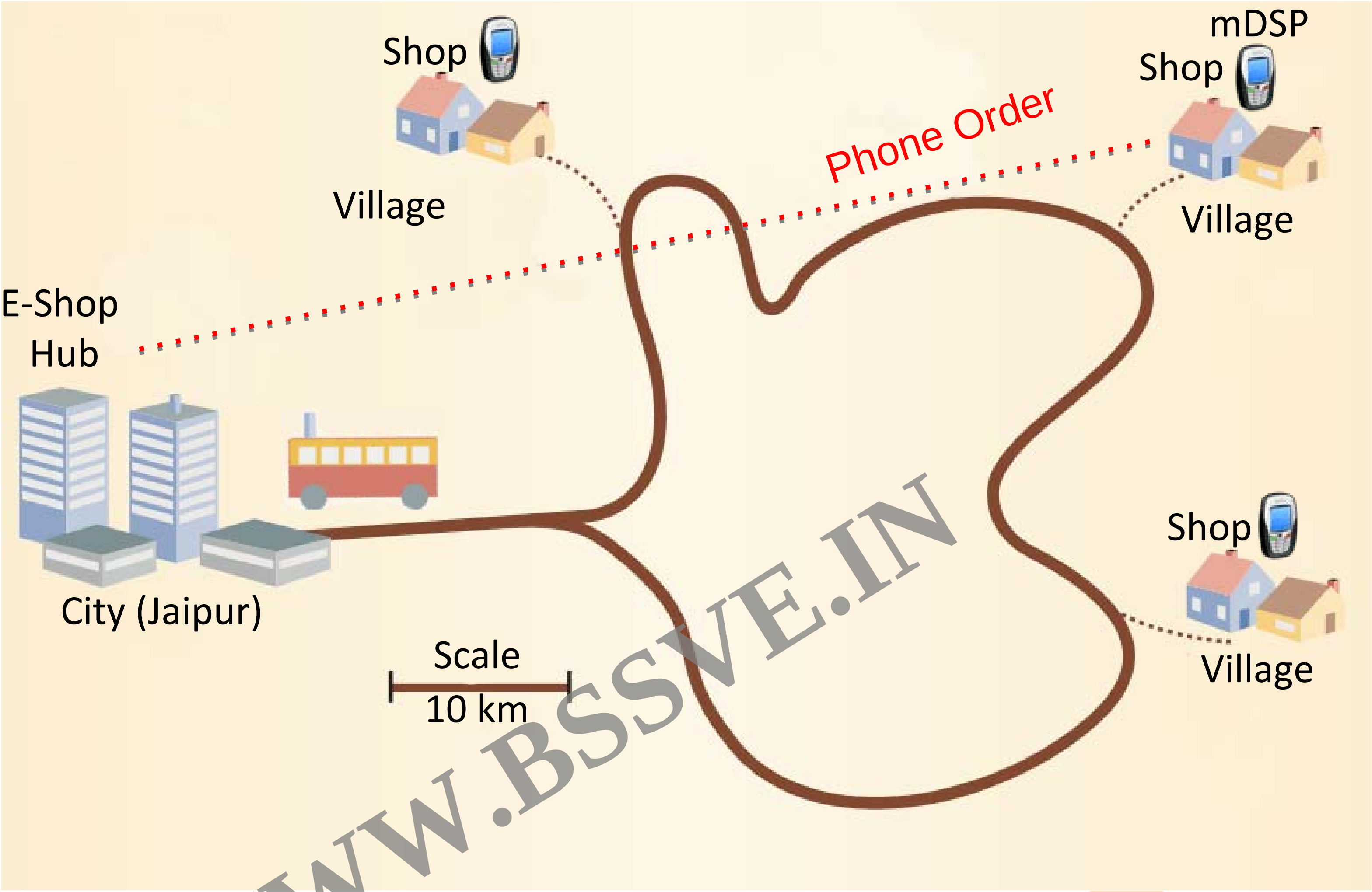
Figures by MIT OpenCourseWare.

- MIT Startup founded in 2003
- Empower two billion rural people by delivering information, communication, goods, and services.
- Started with store and forward, drive-by wifi for rural connectivity
- Evolved into rural information and goods distributor

United Villages E-Shop

Base diagram from Pentland, Fletcher and Hassan. "DakNet: Rethinking connectivity in developing nations." *IEEE Computer* 37 no. 1 (2004): 78-83. Copyright (c) 2004 IEEE. Used with permission.

United Villages E-Shop



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United Villages E-Shop

Base diagram from Pentland, Fletcher and Hassan. "DakNet: Rethinking connectivity in developing nations." *IEEE Computer* 37 no. 1 (2004): 78-83. Copyright (c) 2004 IEEE. Used with permission.

Problems with Current Situation

- Expensive
  - Airtime & staff operators
  - Catalog is expensive to print
- Error Prone
  - Transcription of order by UV operator
- Inefficient
  - Time consuming
  - Not optimized for reoccurring orders
  - Searching catalog is not intuitive
- Not Scalable
- Record-less
  - No persistent record of transaction
- Hard to support UV's future plans

Needs Assessment

- Technological requirements:
  - J2ME for phone application
  - SMS for transport layer
  - Appropriate tech. with ability to support advanced features
- Catalog updates required
  - Prices and products require monthly updates
- English literacy is high across mDSPs

Needs Assessment

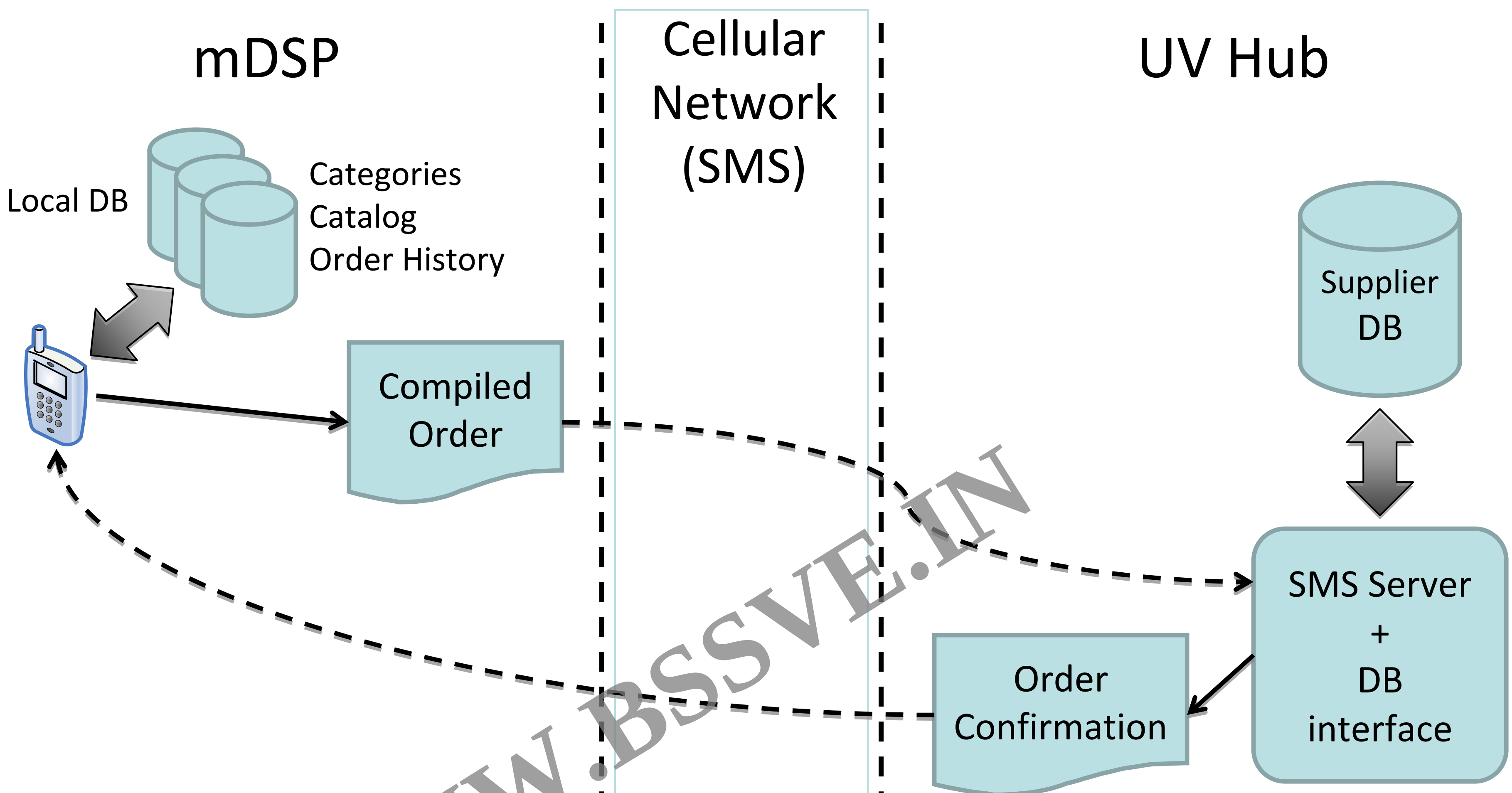
- 75% of mDSPs do **not** own a J2ME-enabled phone
  - Solution: incentivize purchase of J2ME-enabled phone

- At $75 for a phone, the average mDSP can break even after 2 months
  - Assuming $46 monthly profit and various travel expenses (see Appendix)

Our Solution

- Design a J2ME application with tested e-commerce modalities:
  - Search by product code
  - Search in product name and description
  - Shopping basket
    - Order multiple products per order (per SMS)
  - Order confirmation
  - Order history
    - Data on costs and profit
    - Ability to reorder a past order

System Diagram



Sustainability Overview

Financial

- No upfront costs for United Villages, low continuing costs of operations
- Mobile DSP break even on new phone purchases within two months

Technological

- Utilizing Open Source and industry standards
- Recommendations to engage developer or future NextLab teams
- Focus on clear documentation and training materials

Operational

- Identified key behavioral changes needed
- Defining process and documentation to ensure sustainability

Human

- Focused on building and strengthening relationships with key stakeholders at all levels of the United Villages organization

Pilot Plans

- 3 team members are traveling to Rajasthan in January for a pilot
  - Funding generously provided by nextlab and UV
- 10-day pilot:
  - Iterate over the design of the new system
  - Compare the new system to the old workflow
  - Test the robustness of the SMS layer
  - Begin working on hand-off to UV

Conclusions

- Successful in developing a system that meets the needs of United Villages.
- Broader impact because the system is open-source and can be adopted by other parties.
- Will the system be embraced by mDSPs?

Future Plans

- Develop system into a fully-featured m-commerce platform:
  - Access to customer information
  - Business analysis features for mDSPs
  - Pre-paid card support for payment
  - Targeting sales and promotions
  - Anticipate supply problems
- Develop solutions for end-customers (villagers)

APPENDIX

Financial Mobile DSPs Economics
Key Question # 1: Will mDSPs purchase J2ME phones?

Upfront Costs

- J2ME-enabled phone: $75
- Training costs: $17 (5 hours for travel and training at $3.50 / hour)[1]

On-going Costs (Monthly)

- SMS: $0.04 ($0.02 per message x 2 orders per month)
- Monthly catalog updates: $14.00
  - 4 hour round trip (travel + time in head office)
  - Average hourly salary $3.50

Gross Profits (Monthly)

- Average Monthly Gross Profit = $45.96

Break Even

Monthly Gross Profit	x	Months	=	Upfront Costs
$45.96	x	M	=	$92.50
		M	=	$92.50/
		M	=	2.01
				months to break even

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Fall 2008

United Villages – Mobile Interface

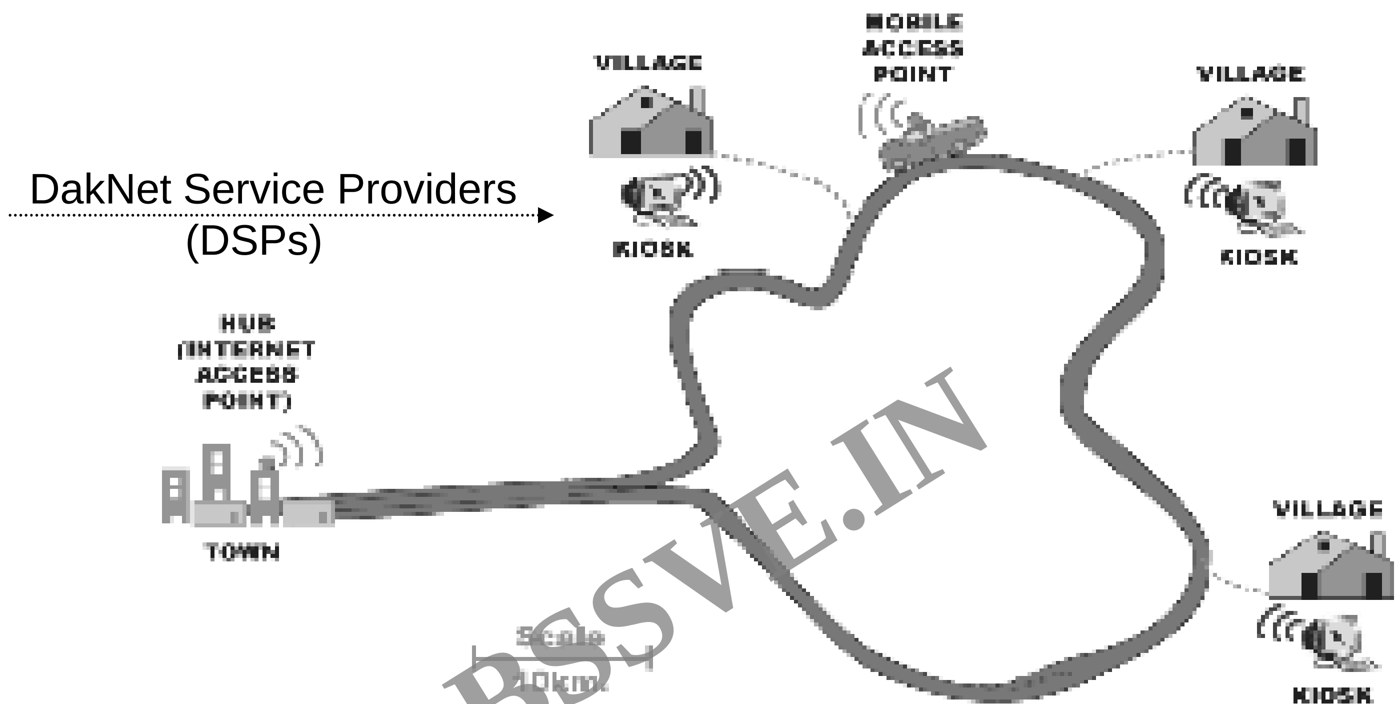
Anastasios Dimas
Michael Gordon
Anonymous MIT student
Dev SenGupta

nextlab

Elevator Pitch

"United Villages – M-commerce Interface **is a** solution **that** empowers the rural poor to make purchases using a mobile phone that **unlike** the legacy system that involves many human intermediaries, is a cost-effective and user-friendly system"

Present – DakNet



“Glue that sticks together those areas that have mobile connectivity and those that don't “

- CEO (UV)

Courtesy of Amir Hasson and Richard Fletcher (First Mile Solutions). Used with permission.

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DakNet – Mobile Commerce

- “Bandhu” (salesman) is the human interface to village customers. They go door to door with a Catalog (items).
- DSPs compile the orders from Bandhus and any directly placed bulk orders.
- Orders are relayed to District Office using a web-interface via DakNet and recently through phone calls and SMS.
- Goods are delivered to village kiosks where customers later pick them up.

Exuberance

- UV has an order-fulfillment system!
  - Which is rare in the developing world.
- We have an opportunity to develop a system that would impact many rural communities.

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Problem Background

- Legacy software system – web-interface, spreadsheets.
- Multiple levels of human interfaces, Villagers to Bandhu, Bandhu to DSPs.
  - Inefficient
  - Error-Prone – order-taking, SMS errors
  - Expensive - Voice calls are expensive to fix the many errors
- Delay in delivery, loss to customers and company.
- Need a robust system that can be scaled.

Proposal

- Understand user needs on the ground and analyze them to develop system requirements.
- Design and Develop a user-friendly mobile user interface that would enable “Bandhus” and villagers to browse and order goods using mobile phones.
- Do thorough business analysis of the viability of such a system and provide recommendations to prove long term sustainability.

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Related Work

- Mobile money transferring systems
  - M-PESA in Kenya
  - Globe in Philippines
  - Wizzit in South Africa
- User interfaces for rural poor
  - SMS and Paper
  - J2ME – Good for local error-handling
  - Targeting the illiterate – pictures/cartoons, videos, numbers
- We couldn't find a mobile order-placement system for physical goods in developing world

Possible Solutions

- SMS + Catalog
  - Pros – LCD technology, Existing Modality
  - Cons – Expensive Catalog and non-local error handling
- Interactive voice response (IVR)
  - Pros – Anyone can use it, targets illiterate
  - Cons – Implementation/Language issues, signal strength requirement
- J2ME apps that includes catalog
  - Pros – local error handling, electronic catalog, richer UI
  - Cons – Portability, Application installation & updates, phone capabilities
- Smartphone viability
  - Pros – Single HW platform, rich UI, feature rich (GPS, WiFi)
  - Cons – Expensive, Scalability - intermediary

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United Villages
Mobile Commerce Interface

Anastasios Dimas
Michael Gordon
Anonymous MIT student
Dev SenGupta

Needs assessment – Required info

- Needs
  - Preliminary User Survey (Prashant)
- Context
  - Social Context (Dev)
  - Technology (Michael)
  - Economics of Technology (Michael)
  - User behavior (Anastasios)
- UV Economics
  - Questions for UV (Dev)

Legacy: Orissa (Behampur)

Courtesy of PlaneMad. Used with permission.

Population

- 36.7 million (2001 Census)

Urban/ Rural

- 87% of the population live in the villages
- In rural areas over 65% of the population have no access to safe drinking water

Education

- The average literacy rate in Orissa is 63.08% (2001)
- Male literacy rate is 75.95% and female literacy rate is 50.51% (2001)

Economy

- Size: $18 billion (2004 estimate)

Legacy: Orissa Case Study (2007)

Data extracted by **18** Kiosk locations:

Courtesy of PlaneMad. Used with permission.

3 Surveys conducted by UV

- 17 DakNet Service Providers (DSPs) –22 Questions
  - Demographics
  - Customer Satisfaction
  - Service Quality

Purpose: Determine traits common to successful DSPs

- 43 Customers – 19 Questions
  - 7 villages
  - Focused on 2 villages with high percentage of users

Purpose: Determine if current services provide customers a Cheaper means of performing activities like shopping and job Hunting - Savings Matrix.

- 17 Prospective Customers – 15 Questions
  - 7 villages

Purpose: Gather additional data for the Savings Matrix and understand why they have not used DakNet services yet.

Legacy: Orissa Case Study (2007)

Data extracted by **18** Kiosk locations:

Courtesy of PlaneMad. Used with permission.

Results

- DSPs share a strong entrepreneurial spirit
  - 53% of Kiosks are co-located with Public Call Offices – one-stop-shop for communications needs
- DSPs are well-educated (majority have completed grad studies)
  - 90% believe UV training is adequate for e-shop, email, SMS
  - They indicate that more than 50% of customers do not need assistance to use the kiosks.
- Only 55% of DSPs claim that DakNet services "always work"

  ("offline" kiosk status most common complaint)
- 82% claim that DakNet services "work half the time" or "always work"
- DSPs claim that marketing is the most difficult challenge
- There was wide variation in customer activity (0% - 100%) per kiosk (not using an account within 60 days)
- UV personnel claims that DSPs' commitment varied with regard to building their kiosks – initiative required

Legacy: Orissa Case Study (2007)

Data extracted by **18** Kiosk locations:

Courtesy of PlaneMad. Used with permission.

Results

- DSPs claim that lengthy transmission time is a common customer gripe.
- Farmers were cited as the customer demographic they were not reaching.
- Customers stated to DSPs the following future services :
  - Loans
  - E-governance
  - Agriculture queries
  - Shaadi marriage
- DakNet Bandhus (DBs) have proven very successful signing up on average 6 new customers each as reported by DSPs:
  - E-shop
  - Email
  - Job search
- DSPs claim that health services and drinking water community needs could be met by UV in the future.

Legacy: Orissa Case Study (2007)

Data extracted by **18** Kiosk locations:

Courtesy of PlaneMad. Used with permission.

Results

- 59% of villages lack internet access
- Electricity is available 22 hours per day except on heavy rain periods
- 65% of villagers produce some form of handcraft

Service	Time Savings (Hrs)	Savings vs. Alts. (Rupees)
E-Shop	3.6 Hrs	40
Email	1.5 Hrs	23
Job Search	1.1 Hrs	14
Travel Booking	2.9 Hrs	14
Voicemail	.05 Hrs	7
SMS	.02 Hrs	.31

Courtesy of United Villages. Used with permission.

Savings Matrix

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Legacy: Orissa Case Study (2007)

Data extracted by **18** Kiosk locations:


Courtesy of PlaneMad. Used with permission.

Results
(av. monthly personal income per customer: 3,550rps= $74)

Current Substitution Cost Savings per Customer	**Current (Monthly)**
Total E-Shop Cost Savings per Customer	$1.00
Email Cost Savings per Customer	$0.30
Job Search Cost Savings per Customer	$0.91
Travel Bookings Cost Savings Customer	$0.03
Voicemail Cost Savings per Customer	$0.01
SMS Cost Savings per Customer	$0.01
Substitution Cost Savings per Customer per Month	**$2.26**

Legacy: Orissa Case Study (2007)

Data extracted by **18** Kiosk locations:

Results

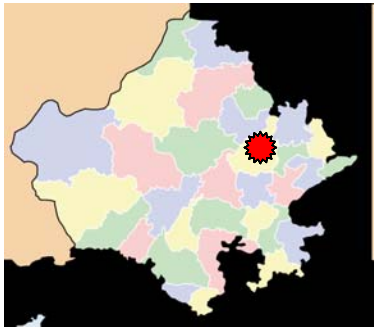
Current Opportunity Cost Savings

	Current (Monthly)
E-Shop Time Savings per Customer	3.6 Hours
Email Time Savings per Customer	0.8 Hours
Job Search Time Savings per Customer	1.8 Hours
Travel Bookings Time Savings per Customer	0.2 Hours
Voicemail Time Savings per Customer	0.002 Hours
SMS Time Savings per Customer	0.02 Hours
Total Time Savings per Customer	6.38 Hours
Average Monthly Income per Customer	$60
Average Hourly Income per Customer	$0.34
Opportunity Cost Savings per Customer per Month*	**$2.19**

Current Focus: Rajasthan - Jaipur

Population	• 56.5 million (2001 Census)
Urban/ Rural	• 78% Rural
Education	• Literacy: 61.03%
Economy	• Size: $11.5 billion (2003). Growth: 6% Ten-year CAGR • Mix: Services (45%), Manufacturing (32.5%) & Agriculture (22.5%)

Courtesy of PlaneMad. Used with permission.



Map: Wikipedia User:Mkeranat

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Technological Context

- Mobile DSPs have their own cell phones
  - Next week we will receive more info on the models
  - DPS have their own mobile plans
- Conflicting information regarding signal strength
  - CTO: Many villages have poor cell reception
  - CEO: Partnering with TATA Mobile to use their data plan
- 20/200 DSPs have computers
- J2ME Applications
  - CEO believes it will not be hard to install applications
- SMS + cue sheet was piloted but proved unpopular
  - CEO: Maybe not pushed hard enough vs. voice
  - Need more info

Possible Solutions

- J2ME apps that includes catalog
- SMS + Catalog
- Internet Portal (WAP)
- Interactive voice response (IVR)
- Voice operator and Call Center

J2ME Application

Pros:

- Rich user experience
  - Graphics: pictures of products
- Local error handling
- Catalog on phone?

Cons:

- Requires more advanced phone
- Development and portability issues
- Installing application requires Internet connection or computer + cable (or Bluetooth)
- Updating application requires reinstall
- Acclimation time for new modality
- Cost?
  - May require multiple SMS messages

SMS + Paper Catalog

Pros:

- Lowest common denominator technology
- Existing Modality
  - Tried but failed, why?

Cons:

- Cost:
- Catalogue required:
- Catalog has SMS format, instructions, and products
- Non-local error handling
- Multiple SMS messages
- Not guaranteed delivery
- Must acknowledge everything

Internet Portal (WAP)

Pros:

- Centralized solution
  - Easy to update application and catalog
- Probably the future of mobile commerce
- Rich user experience
- Personalization of content

Cons:

- Requires data coverage and data plan
- Expensive for users

Interactive Voice Response

Pros:

- Targets illiterate
- Works with any phone
- Does not require human operators

Cons:

- Development difficult
  - Language issues
  - IVR system difficult to program and maintain
- Requires voice signal strength
- New modality?
  - Requires adaptation
  - History of annoying developed-world users

Voice Operators and Call Center

Pros:

- Targets illiterate
- Works with any phone
- DSPs are accustomed to speaking with UV
- Easy to convey additional information
- Allows for personalized interaction
- Might attract more users
- Error detection and correction done with operator

Cons:

- Have to pay for operators
- Might still require a paper catalog
- Requires voice signal strength
- Cost?
- Possibility of busy signal

A Recent (Unpublished) Study*

- Goal: Compare data entry error rates and costs for
  - J2ME Forms Application
  - SMS + cue sheet
  - Voice operator
- Location: Gujarat, India
- Participants: 13 healthworkers
  - 7 owned cell phones
  - All but 2 had used cell phones in the past
  - Education level ranged from 10 years to BA
- Partipants were trained on each modality

* Thies et al., Evaluating the Accuracy of Data Collection on Mobile Phones: A Study of Forms, SMS, and Voice.

Results of Study: Error Rate

- Task required 11 fields to be completed
- Error rates (per field) across everyone:
  - J2ME: 4.2%
  - SMS + cue sheet: 4.5%
  - Voice Operator: 0.45%
- Error rates (per field) across phone owners:
  - J2ME: 2.6%
  - SMS + cue sheet: 3.3%
  - Voice Operator: 0%
- Average interation time:
  - J2ME: 1:39
  - SMS + cue sheet: 1:37
  - Voice: 2:20

Technological Context

- Cell phone subscribers:
  - Orissa: 6.1 Million (1.1 Million CDMA)
  - Rajasthan: 16.4 Million (4.2 Million CDMA)
- Olufemi Omojola, CTO UV:
  - Many villages don’t have a strong enough signal to support voice (Olufemi Omojola, CTO UV)
  - Not many villagers have cell phones
  - Most village stores did not have computers but did have cells
  - J2ME apps do exist and infrastructure exists t... apps on phone
    - Stores with computer and cables for phone

Technological Context

- Cell phone penetration among villagers in target villages?
- Are shared phones popular?
  - If so, who is providing the phones?
- Cell phone reception in target villages?
- What is the popularity of each of these modalities?
  - SMS
  - J2ME applications
  - Voice
  - Internet / WAP

Cost of Technologies

- How much is a cheap phone?
  - J2ME capable?
- What is the cost of the following services?
  - SMS
  - Voice
  - Internet

Cost Considerations

- In Gujarat costs are the following:
  - 3 RS per 3 minute phone call
  - 1.5 RS per SMS
- Voice operator solution has seemlingly largest cost
  - Operators
  - Cost for call
- But could the Operator model attract the most users
  - Illiterate users
  - Existing and comforting modality to speak with a person
  - Users with basic phones (don't support J2ME)
  - SMS could require many messages (J2ME and SMS)
    - Acknowledgement messages
    - Order multiple products
    - Error correction

- Need Assessment Questions
- General Demographics
  - Age
  - Male/Female?
  - Education Level
  - Type of work
  - Family size
- Buying Pattern
  - Daily/weekly Needs – small items (food items, music, movies etc.)
  - Monthly Needs – bulk/large/infrequent items (fertilizer, clothes, etc.)
  - Money spent on UV related services (daily, weekly, monthly)
- Financial Capacity
  - Daily/Monthly income
- Technical Capabilities
  - Own a phone?
    - If so, how much did you pay for it?
    - Do you plan to buy a new phone soon?
      If so, why?
        More features?
  - Type of Phone
    - GSM or CDMA? (Who is your carrier?)
    - Does the phone support any of the following:
      Java applications
      Internet access
  - Are you able to send and receive SMSs from your dwelling?
  - Are you able to make a voice all from your dwelling?
  - Do you share your phone with others?
    - If so, who?
    - Do you charge them to use your phone?
  - Have you ever used an automated SMS service?
    - If so, did you find it easy to use?
  - Have you ever used a java phone application?
    - If so, how was it installed?
      Internet connection
      Store with cable
  - Have you ever used an interactive phone menu system?
    - If so, did you find it easy to use and were you satisfied?
  - Does your phone have Internet capabilities?
    - If so, have you used them?
    - Do you have a data plan?
    - Are you able to surf pages from your dwelling?

•Response to legacy system

Do you like to interact with Bandhus? (if not why? If yes why?)

Do you like the catalogs?

What specific items do you order (daily, weekly, monthly)?

How satisfied are you with existing service (scale of unhappy to very satisfied)?

Any problems faced – explain below?

Money transaction errors
Delivery delays
Erroneous deliveries
Other..

What changes would you like to see?

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Fall 2008

UV M-Commerce Interface System Design

Anastasios Dimas
Michael Gordon
Anonymous MIT student
Dev Sengupta

Massachusetts Institute of Technology

nextlab

The Situation

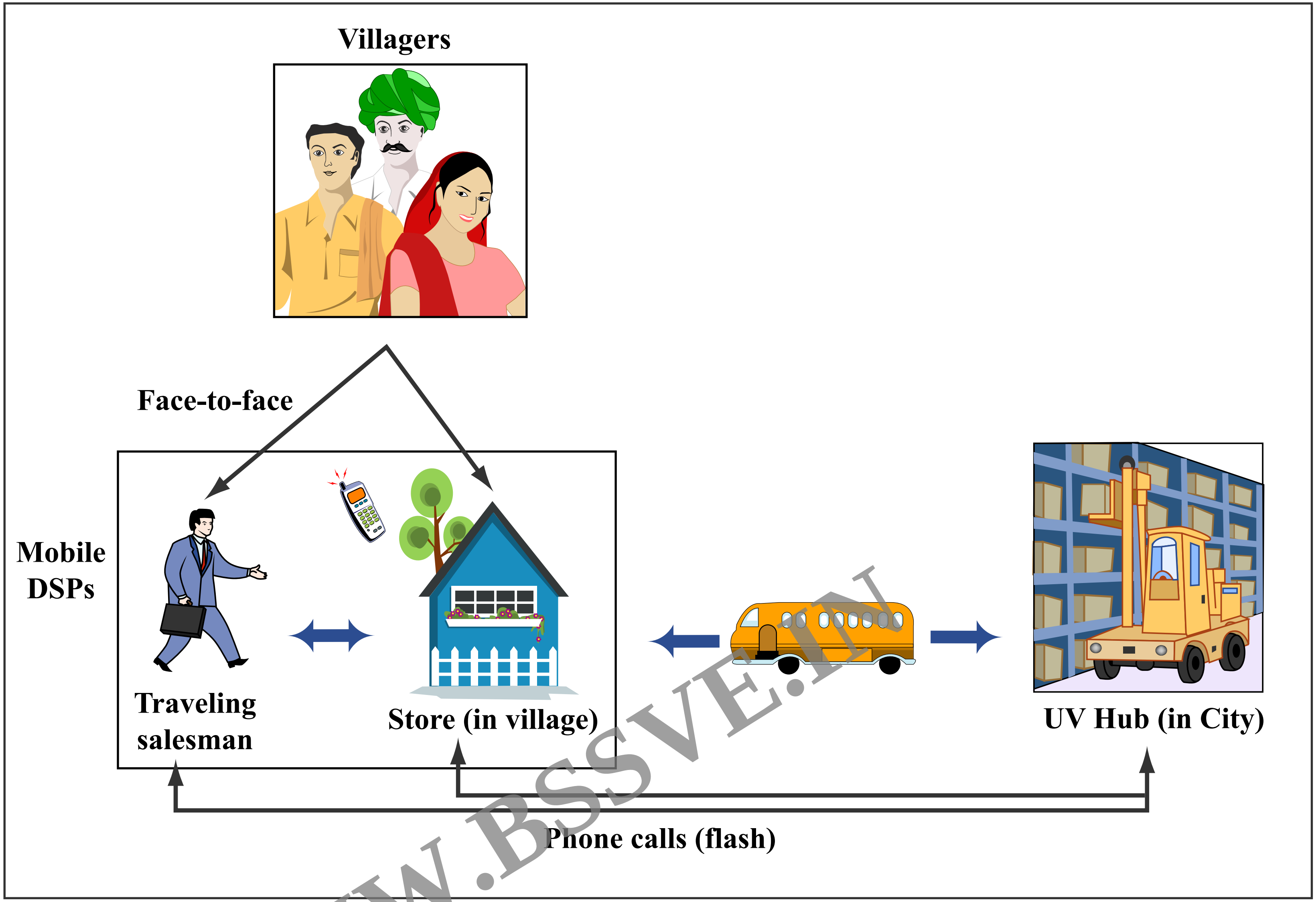

Figure by MIT OpenCourseWare.

Feedback From United Villages

- We are not targeting the Villagers, we are targeting the shop owners and travelling salesmen
- UV wants a J2ME solution, no more voice phone calls!
  - Version 1, simple
    - Place order
    - Order confirmation/history
  - Version 2, advanced features
    - Registration of customers
    - Payment via pre-paid cards
    - Price negotiations
- UV wants 2 deliverables
  - J2ME solution, Version 0.8
  - Study of effectiveness of solution

Feedback from United Villages

- Piloted an SMS ordering system
  - MDSPs willing to absorb cost of SMS
- It failed (call volume did not decrease):
  - Order products not in the catalog
  - Catalog does not have prices
  - Price negotiation
- (Will a J2ME implementation address these problems?)

Changes to the Ordering System

- Add prices to Catalog
- Set policy for volume discounts
- Items numbers more phone-input friendly

Technology Survey

- What type of devices are being used by the Mobile DakNet Service Providers (MDSPs)?

- 20 responses
  - 15 of 20 phones don't support J2ME!
  - 10 of 20 phones don't have color screens!
  - Maximum screen size is 176x200 pixels

Massachusetts Institute of Technology

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Solution

- Require the MDSPs to have a J2ME-enabled phone
- Currently deciding on suggested phone
  - MIDP 2.0
  - JSR 75 (persistent storage)
  - JSR 205 (Wireless messaging API 2.0)
  - Bluetooth for app install

Needs Assessment


United Villages Mobile DSP e-Shop Survey

1. Village you serve? ____________

2. When placing an order with United Villages e-Shop, on averag… different products do you order per phone call?

3. Have you ordered products using SMS (text message) from UV…
   a. Yes (Please answer Question 4)
   b. No

4. If you answered yes to the previous question, did you find SMS… to use? Did you find it frustrating? Please comment on your…

5. If you have used SMS to place an order from the e-Shop, did y… call UV regarding the order?
   a. Yes
   b. No

6. Why do you speak to an operator at UV e-Shop to place an order (instead of using SMS)? (Circle all that apply)
   a. Ask for prices
   b. Negotiate prices
   c. Volume discount
   d. Order products not in catalogue
   e. SMS takes too long
   f. Do not trust SMS
   g. I want to verify my order
   h. Cost of SMS
   i. Check on the status of an existing order

7. Have you installed any (Java) applications on your phone?
   a. Yes
   b. No
   c. Do not know

8. Do you keep **records** of your orders or the orders you take?
   a. Yes, I use written records
   b. Yes, I use a computer for my records
   c. No

We are considering the development of an application that will run on your mobile phone that will allow you to order from UV e-Shop. It will allow you to specify multiple products and a quantity for each product, and send the order via SMS (text message) to UV e-Shop. After the order is placed, verification will be sent to your phone and displayed by the application. Questions 9 and 10 refer to… Here is an example flow of the application:

9. If you were able to order using a system… above,… it?
   a. Yes
   b. No

10. What do you think would prevent you from using the system?… all that apply)
   a. Doesn't allow price negotiation
   b. Too expensive (multiple SMS messages)
   c. Time consuming
   d. I feel more comfortable speaking with an operator
   e. Other: ____________

11. How would you improve on the proposed system? What features are missing? Please comment.

12. We are considering a version of the e-Shop catalogue for your mobile phone. You would be able to search the catalogue on your phone, view the item description, item number and price. Pictures of the products could be displayed. If we developed this, would you use it?
   a. Yes
   b. No (Please answer Question 13)

13. If you answered no to the previous question, why would you not use the e-Shop catalogue on your mobile phone? (Check all that apply)
   a. My phone screen is too small
   b. Pictures don't look good on my mobile phone
   c. Typing into my mobile phone is hard
   d. I don't want to show customers my mobile phone
   e. I don't use the paper catalogue
   f. Cost, it is expensive to charge my phone
   g. Cost, it is expensive to load applications on my phone
   h. It would be too time-consuming, I prefer paper
   i. Other: ____________

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Needs Assessment

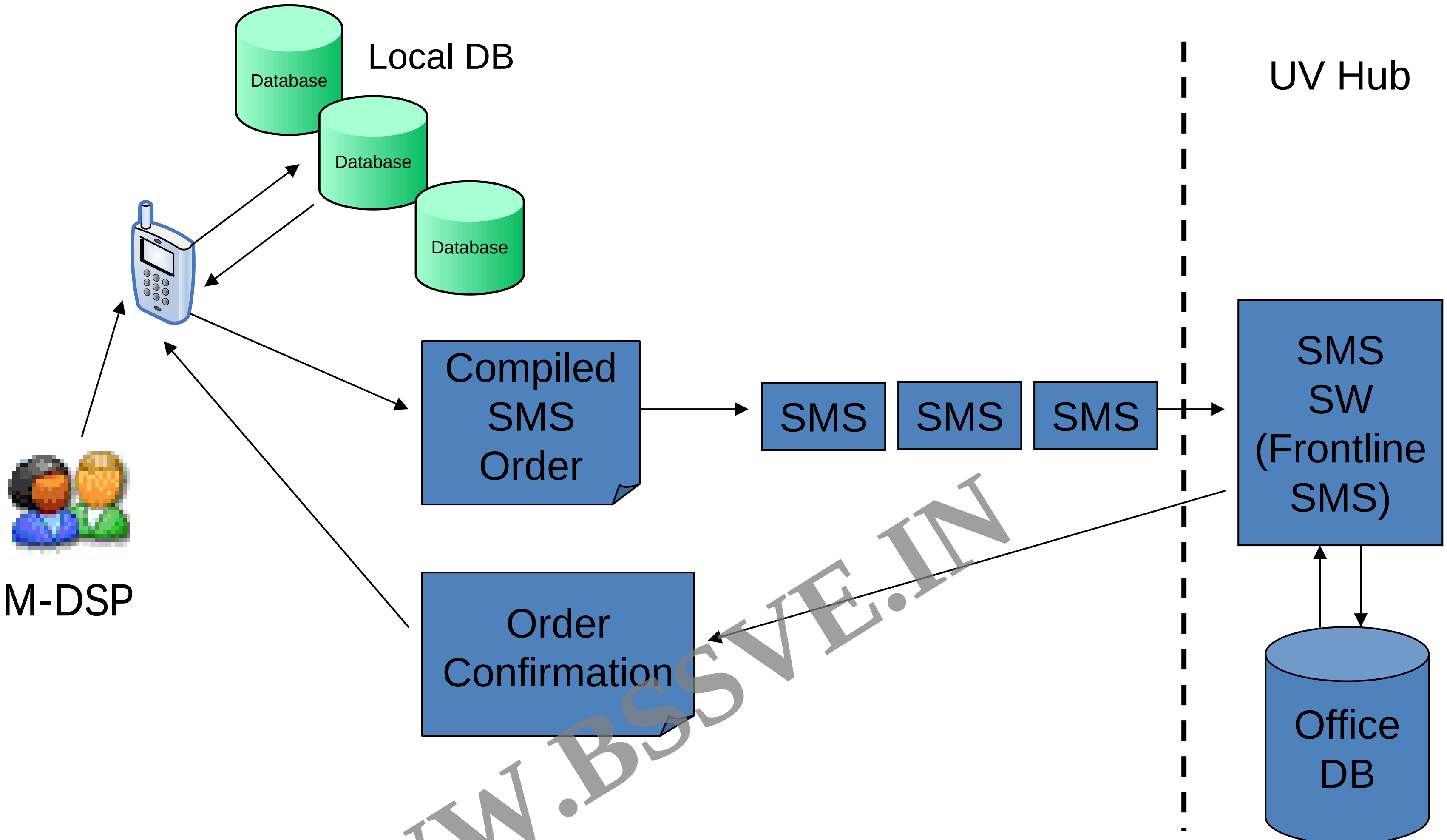
- 13 questions
- Questions focus on:
  - Why didn't you use/like the SMS ordering system?
  - Why do you speak with an operator at UV?
  - Would you use an application for ordering from the e-Shop?

Use Cases

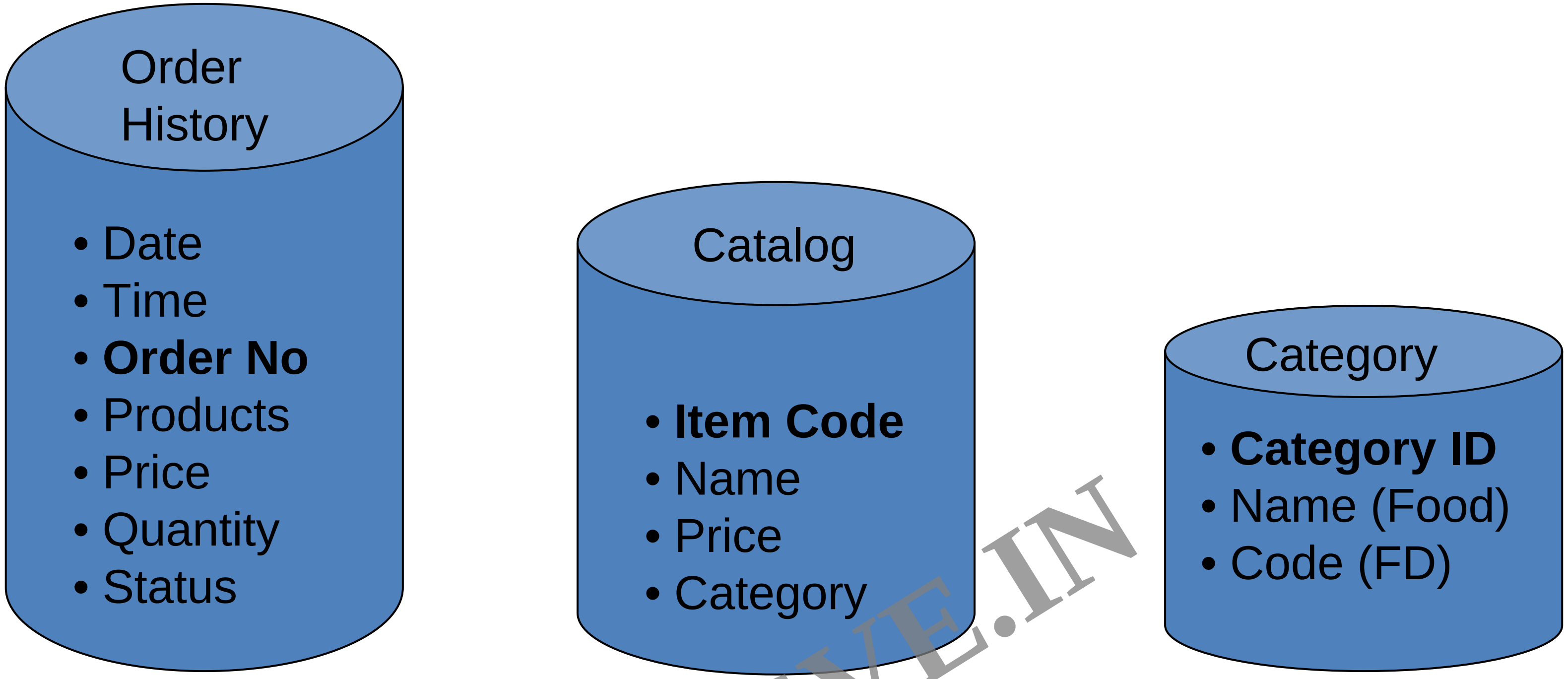
1. MDSP orders product(s)
   - Searching for product(s)
   - Specifying quantity of each product
   - Receiving confirmation from UV hub
2. Check on status of order
3. MDSP checks his/her order history
   - Reorders
   - Check his/her profits

J2ME Proposed Design

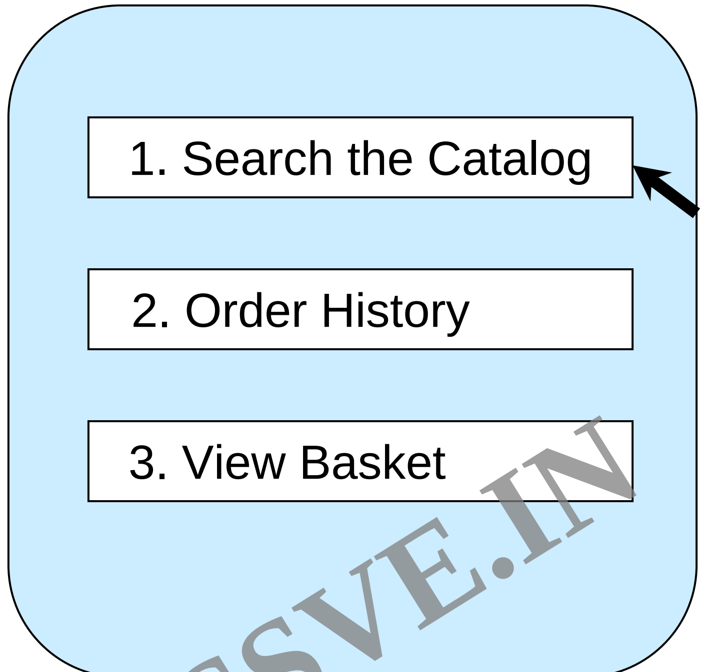
System Diagram



Databases

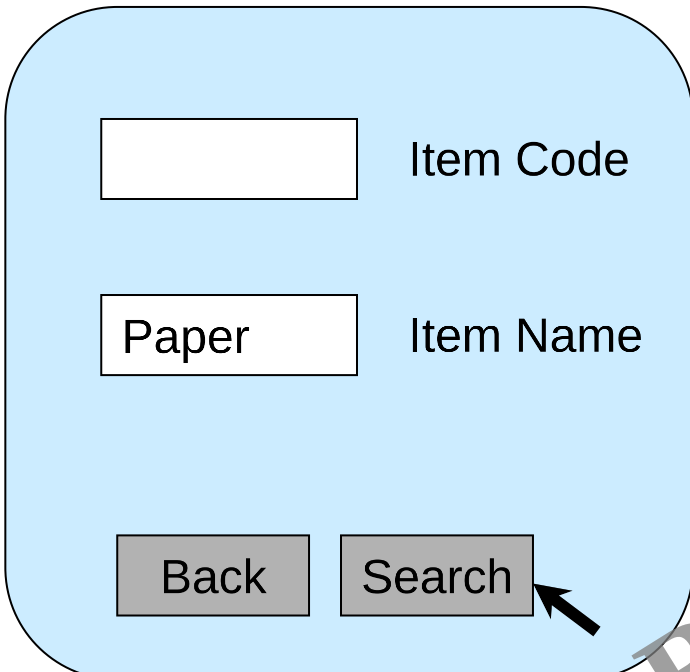

Order History
• Date
• Time
• **Order No**
• Products
• Price
• Quantity
• Status
Catalog
• **Item Code**
• Name
• Price
• Category
Category
• **Category ID**
• Name (Food)
• Code (FD)

User Interface Design



Search the Catalog

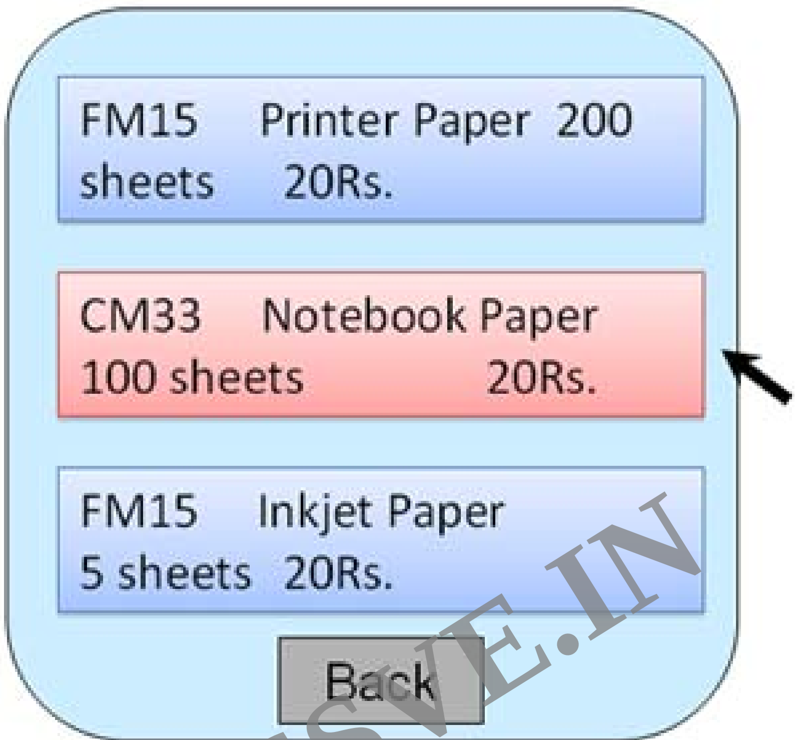
Menu



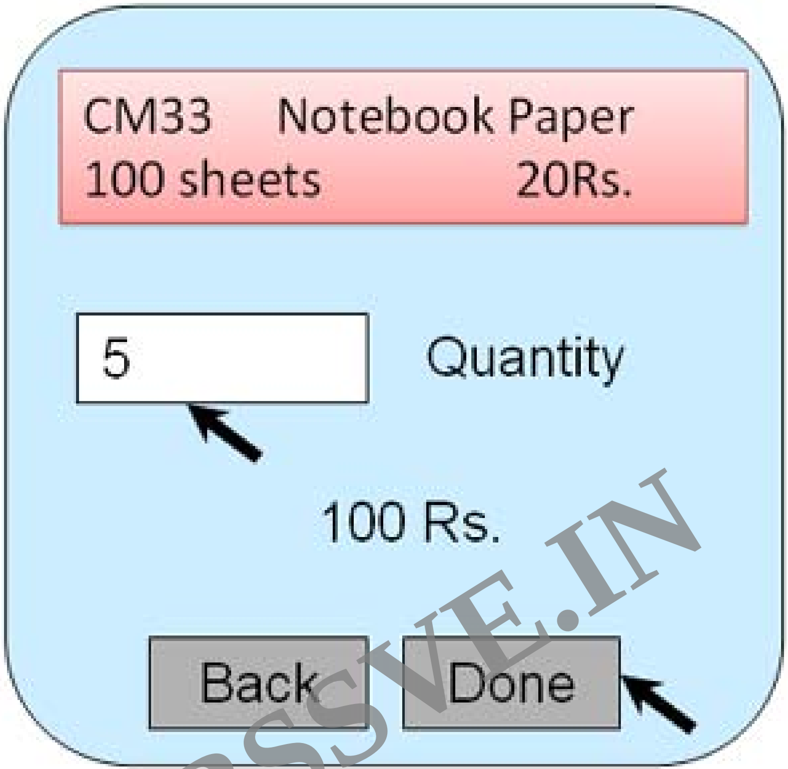
Steps (Screens):

1. Search by item code, name
2. Browse Listings (name, price)
   - Select Item
3. Enter Quantity
   - show total price
4. Add to Basket

Browse Listings

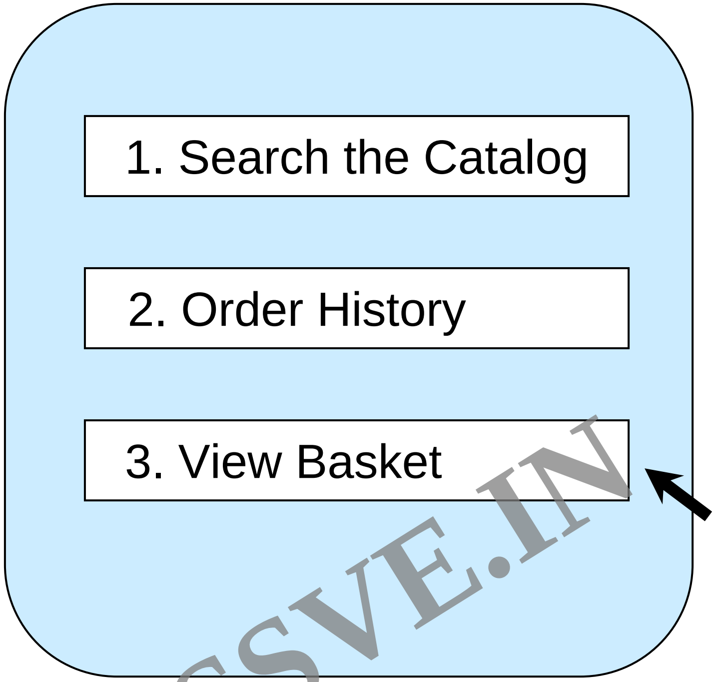


Enter Quantity



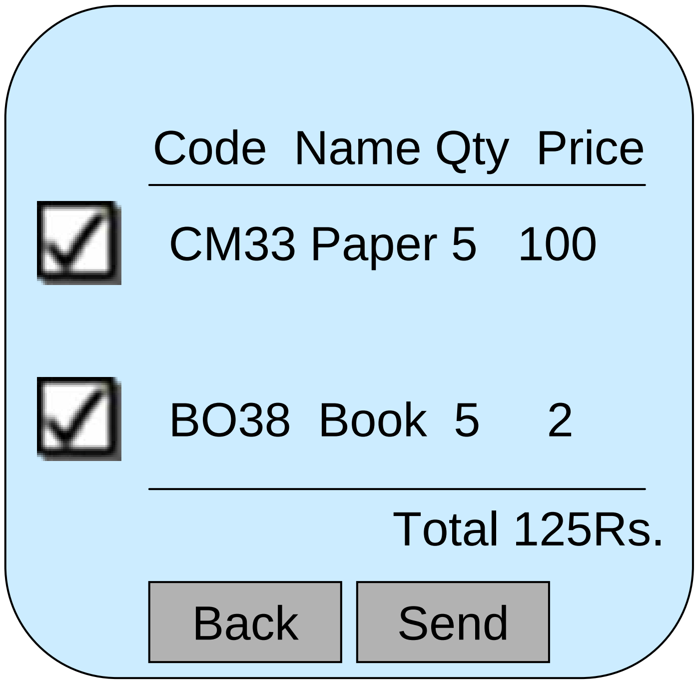
User Interface Design

- Top level Menu



View Basket

Menu



Steps:

1. Select/Deselect – add/remove
2. Check total price
3. Send

Order Confirmation

Order Confirmation

Your order number is O45

Done

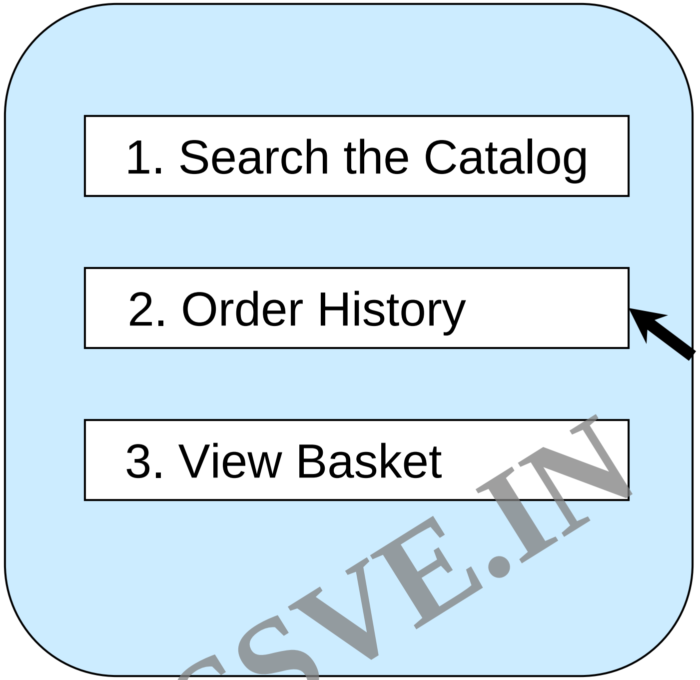
Order Cancelled

There was something wrong with your order, a UV representative will call you shortly. Have a nice day.

Done

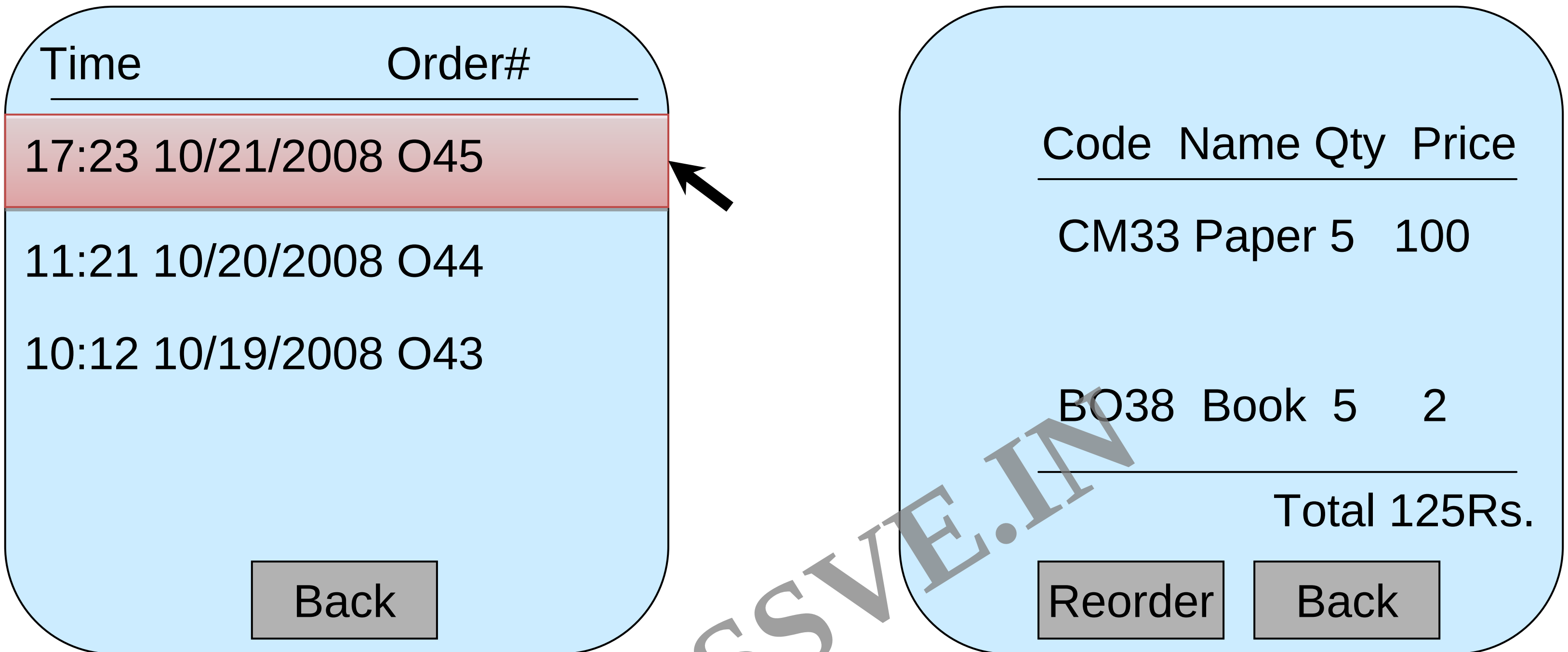
User Interface Design

- Top level Menu



Order History

Menu



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UV M-Commerce Interface Sustainabilty

Anastasios Dimas
Michael Gordon
Anonymous MIT student
Dev SenGupta

Massachusetts Institute of Technology

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Project Overview

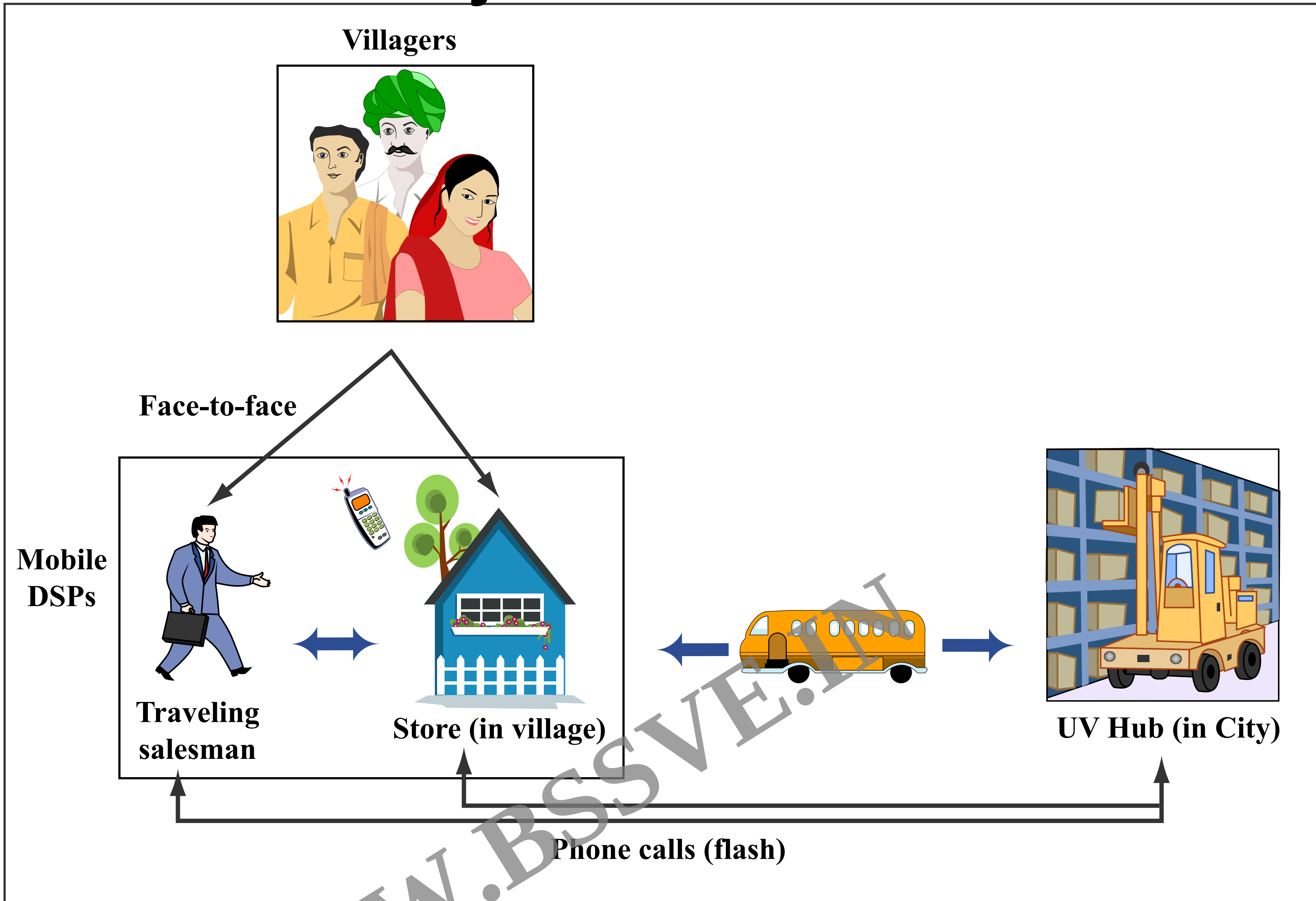

Figure by MIT OpenCourseWare.

Overview

Financial

- United Village Operations
- Mobile DSP perspective (phone purchase, use)

Technological

- Utilizing Open Source and industry standards
- Recommendations to engage developer or future NextLab teams
- Focus on clear documentation and training materials

Operational

- Identified key behavioral changes needed
- Defining process and documentation to ensure operational sustainability

Human

- Focus on building and strengthening relationships with key stakeholders at all levels of the United Villages organization

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Financial Sustainability Summary

- Mobile DSP Perspective
  - Key Question # 1: Will mDSPs purchase J2ME phones?
  - Key Question 2: Will they use the new system instead of flashing calls?
- UV Operations perspective
  - Cost/benefit of the M-Commerce interface?

Financial Mobile DSPs Economics
Key Question # 1: Will mDSPs purchase J2ME phones?

Upfront Costs

- J2ME-enabled phone: $75
- Training costs: $17 (5 hours for travel and training at $3.50 / hour)[1]

On-going Costs (Monthly)

- SMS: $0.04 ($0.02 per message x 2 orders per month)
- Monthly catalog updates: $14.00
  - 4 hour round trip (travel + time in head office)
  - Average hourly salary $3.50

Gross Profits (Monthly)

- Average Monthly Gross Profit = $45.96

Break Even

Monthly Gross Profit	x	Months	=	Upfront Costs
$45.96	x	M	=	$92.50
		M	=	$92.50/
		M	=	2.01
				months to break even

Financial Sustainability: Mobile DSPs Economics
Key Question 2: Will they use the new system instead of calling?

Primary reasons for calling

Preliminary

Call Reason	Calls / mDSP	Minutes / Call
Orders Placement	2	5
Order Status	1	3
Price Requests	2	3
Negotiations	2	8
Product Requests	1	3
Volume Discount	1	5

Solution address the problem

- The new system will address large sources of call volume
  - Price requests
  - Order confirmation
  - Volume discount
- However, adoption will be challenged by the persistence of
  - Negotiation inclination
  - Off-catalog product requests
- Policy decisions may force usage

Financial Sustainability: United Villages Operations Perspective

Upfront Costs	• Software development: Next lab team ($0) • Software licenses: Open source ($0) • Hardware requirements: Servers already in place
On-going Costs	• SMS: $0.015 per message • SMS volume: 20 (2 orders per DSP and 10 mDSPs) • Assuming: NextLab team can continue development
Benefits	• Initial estimates suggest that UV will be able to reduce call volume by 44% • Reduced call volume would enable UV to hire fewer call center operators as they scale up their operations

Technological Sustainability

We have chosen open source software platforms and industry standards

FrontlineSMS

Java
J2ME
CDC

Open Source J2ME relational database

We have developed a plan to ensure technological support beyond January

- Recommending that UV hire a part-time software engineer or continue working with NextLab student teams
- Defining role and responsibilities and ideal skill set
- Documenting existing system and providing training materials to ensure smooth hand-off

Until mobile broadband gains pervasive adoption in rural India, our solution will be technologically sustainable

Operational Sustainability

Change in behavior required…	…by whom?	How are we ensuring operational sustainability?
Regular updates to the catalog	• UV Operations	• Define process for updating catalog (inventory and prices) • Train UV Operations staff on process
Use of the m-commerce interface	• mDSPs	• Create training curriculum for each level of the organization • Train mDSPs during January visit • Suggest policy changes to discourage negotiation and voice-based interactions
Continue updating and improving software	• UV developers • Future NextLab students	• Documentation will be posted on Google Group • Code is stored on Sourceforge

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Human Sustainability

Level of Organization	Who?	Sustainability Commitments required	Actions taken to build goodwill	Next Steps
Executive	• Amir Hasson, CEO • Femi Omojola, CTO	• Commitment to test solution • Commitment to fund further development	• Regular e-mail correspondence	• Regular in-person progress meetings
Operations	• Fulfillment managers and operators	• Commitment to use the new system during pilot • Commitment to learn how to use the new system • Commitment to not call back buyers • Commitment to maintain system (catalog, install new versions on the phone)	• None	• Include in future design discussions via Skype conference calls
Village	• Mobile DSPs (2 per village, 5 villages)	• Commitment to test the new system when it is rolled out • Commitment to dedicate time in January for feedback sessions and interviews • Longer term commitment to use the system provided or provide actionable feedback to United Villages	• Surveyed mobile DSPs on technology usage • Surveyed mobile DSPs on usage/shortcomings of existing system	• Identify the exact set of mobile DSPs who will be included in the pilot program • Further survey these folks to "pre-wire" testing

Questions

Appendix

UV Operation Economics

- Key Assumptions:
  - mDSPs use system, which drives down call volume
  - Next Lab team continues development

Fixed Costs				
	Software Development		$0.00	
	Software Licenses		$0.00	
	Hardware Requirements		$0.00	
Monthly Variable Costs				
	Data Transmissions		$0.31	
		Number of mDSPs	10	
		Orders / mDSP	2	
		Cost / message	$0.02	
	Catalog Updates		$17.50	
		Operations workers time	0.5	
		Hourly Salary of Operations workers	$3.50	
		Number of mDSPs	10	
	Costs Avoided		Volume	Minutes / Call
		Total Call Volume	90	
		Calls Avoided	50	
		mDSPs	10	
		Orders per mDSP	2	5
		Order Status	1	3
		Price Requests	2	3
		Negotiations	2	8
		Product Requests	1	3
		Volume Discount	1	5
		Total Minutes Avoided	190	
		Total Minutes	430	
		Percent of Minutes Avoided	44%	
		Air time charges/minute	$0.04	
		Total Airtime Chargest avoided	$8.44	
		Hourly salary per person	$3.50	
		Total Hourly wages avoided	$11.08	
		Total Costs Avoided	$19.53	

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Milestones

1. Elevator Pitch and Related Work (Sept. 24)
2. Needs Assessments Initial Results (Oct. 8)
3. System Design, and Initial Implementation Results (Oct. 22)
4. Sustainability / Financial Factors (Nov. 5)
5. Feature Complete (Nov. 19), General Progress Report
6. Working Demo (Dec. 1)
7. Final Presentation Event (Dec. 10)

Elevator Pitch

- ________
  is a ____________________
- for
  ____
- that, unlike
  ___________________,
- _________________________

- This is good to have so that:
  - you know what you're doing
  - you can easily explain it to others

* from Hal Abelson's class

Elevator Pitch

- <name>
  is a <service / app / device / platform / ?>
- for
  <purpose, problem that it solves>
- that, unlike
  <alternatives, current way it's done>,
- <what it does differently>

- This is good to have so that:
  – you know what you're doing
  – you can easily explain it to others

* from Hal Abelson's class

Solutions and Related Work

- The Present Solution
  - How are things done now?
  - What is wrong with that?
- Alternative Solutions / Related Work
  - Has anyone else come up with a better solution?
  - Has anyone done something not directly related that may be useful?
- Your solution (what can you do)
  - Just use existing solutions and put them together
  - Modify / extend existing solutions
  - How?

Milestone #1 (Sept. 24)

- Present your elevator pitch (1 minute)
- Present Solutions and Related Work
- What you need to do to prepare
  - talk to your project partner to get context, purpose, and current solution (start now!)
    - this is also a form of Needs Assessment
  - do background research on existing/related solutions
  - write-up your proposed improvement

Milestone #2 (Oct. 8)

- Present Needs Assessment and Feedback results from partner
  - What does your partner think about your proposed solution?
  - Does it fit their needs?
  - How does this affect your plans?
- What you need to do to prepare:
  - present your Milestone #1 report to your project partner (on Sept. 24, regardless of whether your are called)
  - Get their feedback
  - Think about how it affects your proposal / plans

Milestone #3 (Oct. 20)

- System Design and Initial Implementation Results
  - How are you going to achieve your goal?
  - What are the components of the system?
    - block diagram
  - How is it used?
    - users and interface to users
  - How does it work?
    - what happens in different use cases
    - what data moves where?
    - what computation needs to happen?
  - Any potential difficulties?
    - e.g., certain assumed functionality not being available
  - Progress report on initial implementation
- Start working on this asap (Sept. 24 or even before)s

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Milestone #2: Preliminary Needs and Context Assessment

Milestone #2 (Oct. 8)

- **Preliminary Needs and Context Assessment**
- **What does your partner think about your proposed solution?**
  - present your plan (e.g., Milestone #1 report and other materials) to your project partner (on Sept. 24, regardless of whether your are called)
  - Get their feedback
- **Does this affect your proposal?**
- **On-the-ground needs assessment**
  - What questions do you want to ask your target users?
  - (You don't need to have answers right now, but show your questions.)

Social Context

- **See Rachel Hall-Clifford's talk**
  - Contact her for feedback on needs assessments surveys
- **Who generated your idea and why?**
  - Technologically interesting? Perceived need?
- **Does your target population NEED your**
  - product or intervention? Who determines this?
- **Does your target population WANT your product?**
- **How open are you to changing your idea or product to correspond with local input?**

Technology

- **Cell-phone signal in your target locations?**
- **Do the target users have cellphones?**
  - How many have their own cellphones?
  - How many have access to one (e.g., village phone)?
  - Do people who have stores/shops/businesses, government offices, hospitals/medical facilities, schools, etc. have cellphones?
- **How about PCs?**
  - Do individuals have PCs? Laptops?
  - Internet? Dialup or High-Speed?
  - How about public offices (gov't, hospitals, etc.)?
  - How about internet cafes?

Economics of Technology

- **How much?**
  - Cheap phones (contract vs. no-contract)
  - Cheap cameraphones
  - SMS and MMS sending
  - voice
  - Internet / Web access (GPRS & 3G)
  - value-added services
  - **Do you pay to receive?**
- **What percentage of a family's income is spent on cellphone costs?**
  - What is the average income of a family?

User Behavior

- **How literate are your target users?**
- **How often do people use their cellphones and what for?**
  - (Text, chatting with relatives, conducting business, finding out if roads are blocked etc.)
- **What type of people are generally using cellphones?**
  - (Women, children, rich, middle-income, poor?)
- **What special/advanced uses people give their cellphones?**
  - paying for goods? Person-to-Person payments? Websurfing? Gaining local information?
  - Note: there's a difference between what services are available and what services people actually use!
- **Where do they go to top cellphones up?**
- **How often have people had cellphones stolen?**
  - Are people afraid of having their cellphones stolen?
- **Do people pay for goods and services with their phones?**
  - (If so, what? and where? Why do they not use real cash?)
- **Do people find them difficult/easy to use?**

More Questions

- **Think of the largest piece of information you might want to send (image, video, form).**
  - How long does it take to send it?
  - How much does it cost?
- **Details on other modes of use.**
  - What they do currently?
- **What social factors might prevent them from using the phone?**
- **In what situations is it rude to use a phone?**
- **How do people feel about you taking their picture with a cellphone?**
- **Does carrying a cellphone make you feel more successful?**
- **Do you share a phone or ever lend you phone to anyone - if so, for how long?**
  - (This is important if the phone is used as an identifier, or carries private info).

General Tips

- **"High-Tech" / not-so-cheap solutions may be OK if solution/application is such that such solutions only need to be used by a few, and not by the random public**
  - "Target users" are NOT always the same as "beneficiaries"
  - e.g., apps to be used by health workers for data collection / surveying, in a context where funding is available to provide workers with higher-end smartphones
- **If solution is meant to be used by end-users themselves, then need to support lowest common denominator**
- **More challenging, but also more potential for scalability and impact**

Again …

- What is the problem we‘re trying to solve?
- How do we know that's a real problem?
- Does this problem really need a technological solution?
- Could this problem be solved without any digital technology?

Don’t Forget

- Be aware of all these things and try to gather as much information as you can from the partner before and while you are designing your system

- You will almost certainly make mistakes

- The important thing is to be alert and be able to adapt and learn (“Fail early and Fail often”)

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Milestone #3: System Design and Initial Demo

10/8/2008

nextlab

NextLab I, F'08, L9 (Luis Sarmenta) slide 1

Milestone #3: System Design (Oct. 20)

Objectives

- **Have a clear idea of ...**
  - WHAT you are building
  - HOW you are building it
  - What you aim to get done within the class vs. after
- **Get started working on the technical implementation**

Deliverables

- **Write-up**
  - Use Cases
  - Block Diagrams
  - User Interface mock-ups
- **Presentation**
  - Show most relevant use cases and block diagrams
    - Use concrete examples in your presentation
  - Mock ups are OK
  - Initial Demo of what you've gotten to work so far
  - Plan for Priorities / Initial vs. Future featuress

Answer These Questions …

- **What are the components of the system?**
  - block diagram
- **How is it used?**
  - Use-cases
  - User interfaces
- **How does it work?**
  - What happens in different use cases
  - What data moves where?
  - What computation needs to happen?
- **Any potential difficulties?**
  - e.g., certain assumed functionality not being available
  - If so
    - set a date, and responsible person, for determining if it's a problem
    - have a contingency plan
- **Initial implementation results**
  - Progress report
  - Basic demo

Note …

- **Consider input from your Needs / Context Assessment**
- **But … if you don't have it yet, or things are not clear yet, then <u>just go ahead with your system design</u>**
- **This is not the same as ignoring needs/ context**
  - The intent is to draft something and feed it into the feedback loop
  - i.e., you can show your partners your demos
- **Bottom line: START TODAY! (Oct 8)**

Some Examples

- Smart Money
- Smart PasaLoad
- Globe G-Cash
- Adverse Event reporting
- School Info Alerts

An Example from NextLab

- IRD NFC projects
- (insert video here)s

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http://ocw.mit.edu

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moca

mobile care: scalable imaging and diagnosis for the developing world

moca is a customizable, remote medical diagnostics platform for health workers in developing nations.

it is an **end-to-end system** that seamlessly connects health workers in the field to centralized medical experts.

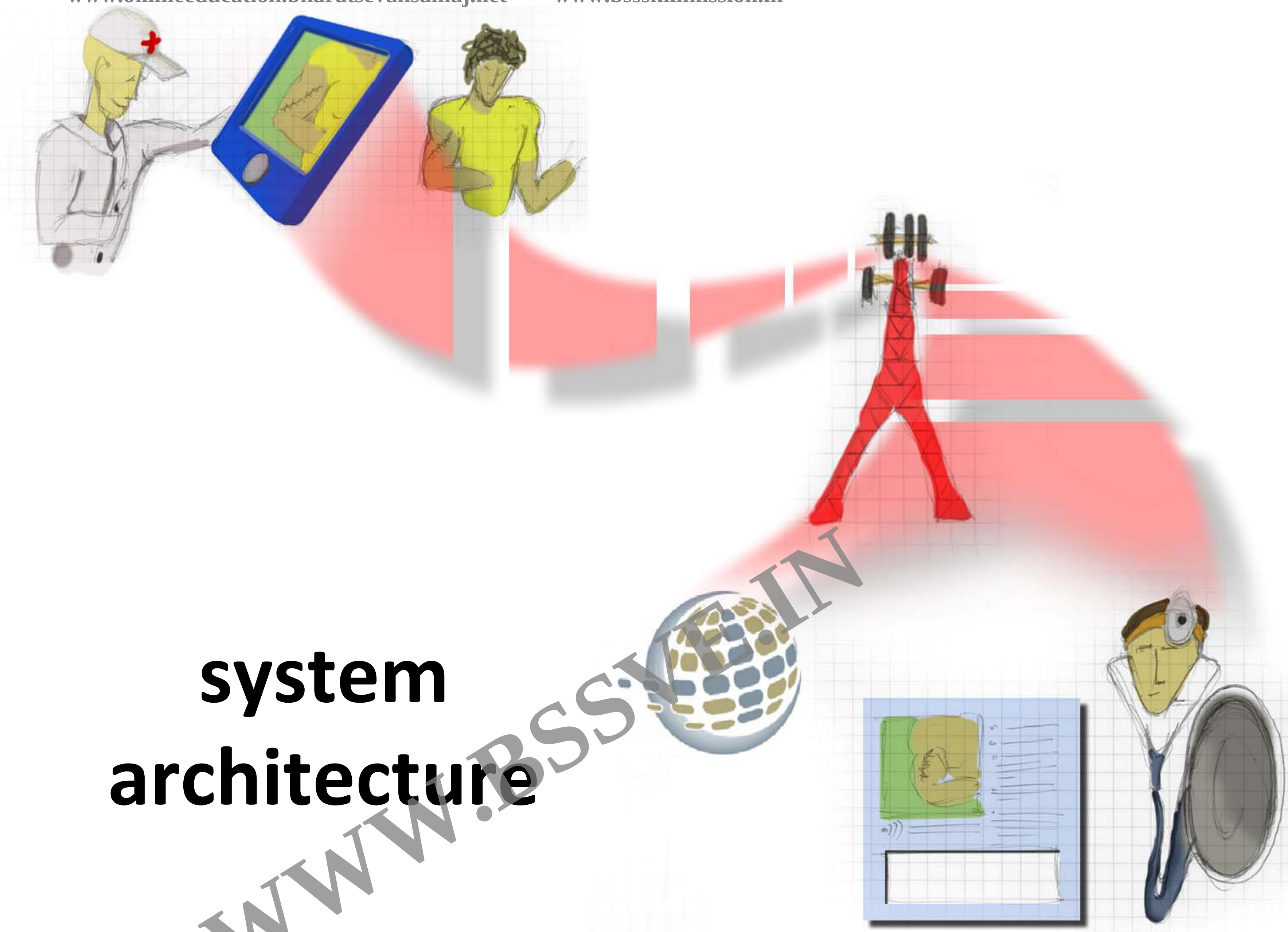
objective

a **lack of trained physicians** is one of the largest issues facing healthcare in the developing world.

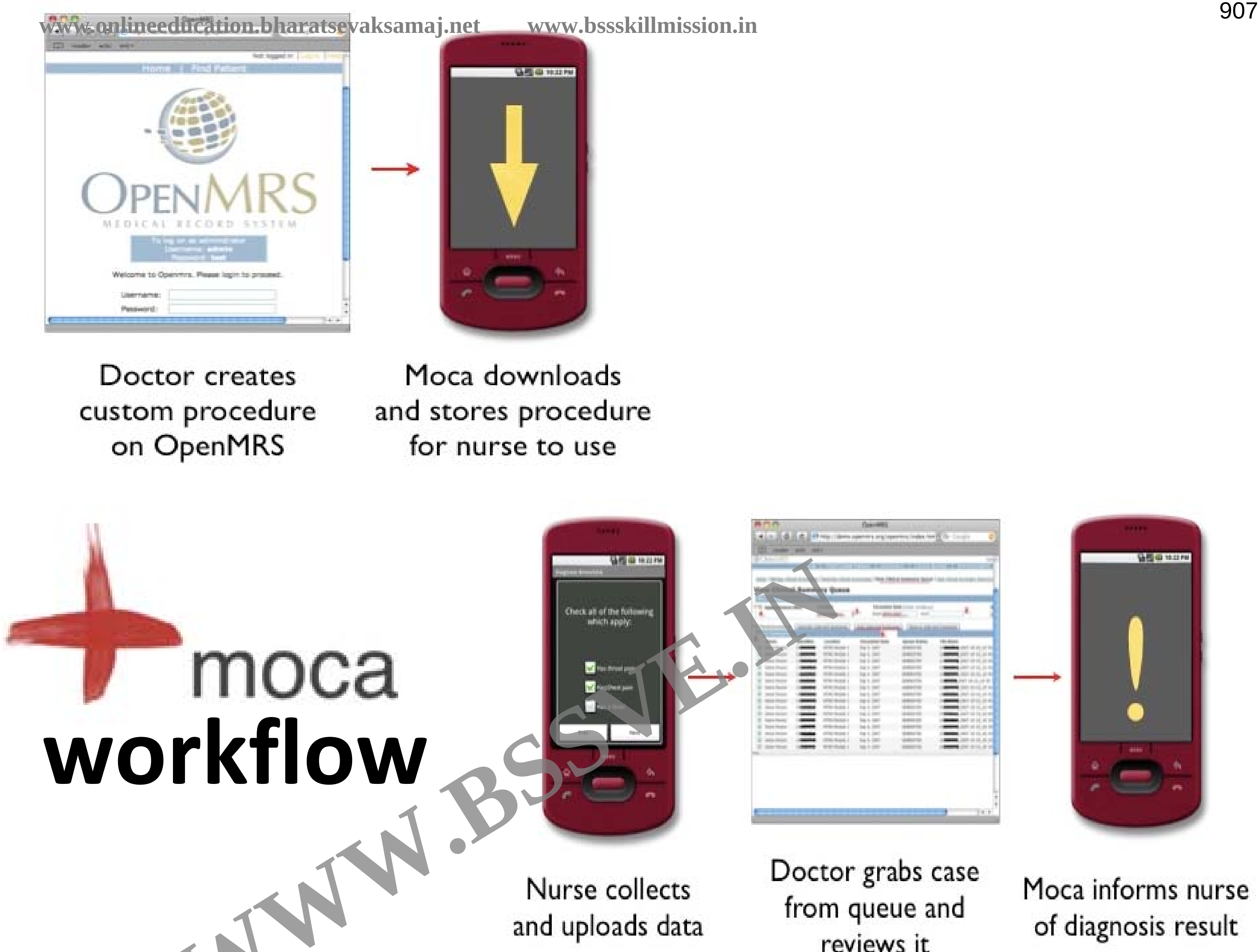
Photo removed due to copyright restrictions.
A group of African children.

patients often make long journeys to clinics, only to be referred to **expensive and far away** medical centers for a diagnosis

paper based medical records further contribute to inefficiencies



system architecture



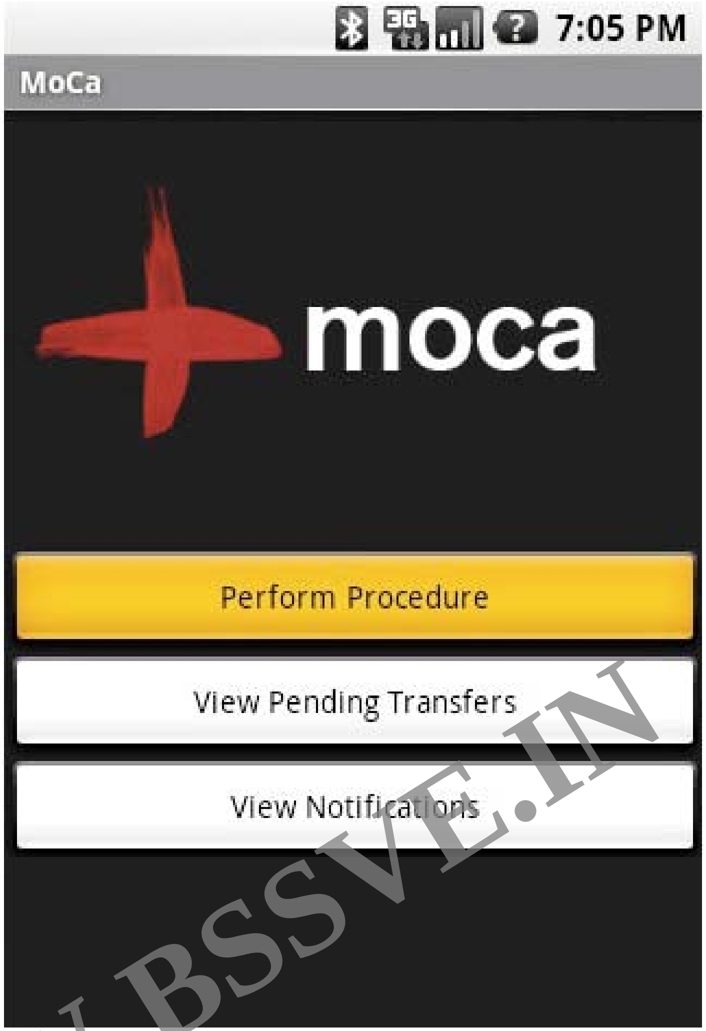
Web interface screenshots courtesy of OpenMRS. Used with permission.

features

- user customizable medical decision trees and forms
- image and audio file support
- integration with medical record system standard
- workflow management for efficient utilization of remote medical experts
- data transfer optimized for poor coverage areas
- open source platform

OpenMRS Integration

- Free and open source electronic medical records system
- Designed for use in developing countries
- Lead by Regenstrief Institute and Partners In Health
- Active deployments in several African and Latin American countries


7:05 PM
MoCa
moca
Perform Procedure
View Pending Transfers
View Notifications

demo

Centers for E-health + Telemedicine:
Universiti Sains Malaysia (Malaysia)
Institut dela Francophonie pour Medicine Tropicale (Laos)
University of the Philippines Manila (Philippines)
University of Gadjah Mada (Indonesia)
Ciputra Univerity (Indonesia)
Hanoi Medical University (Vietnam)

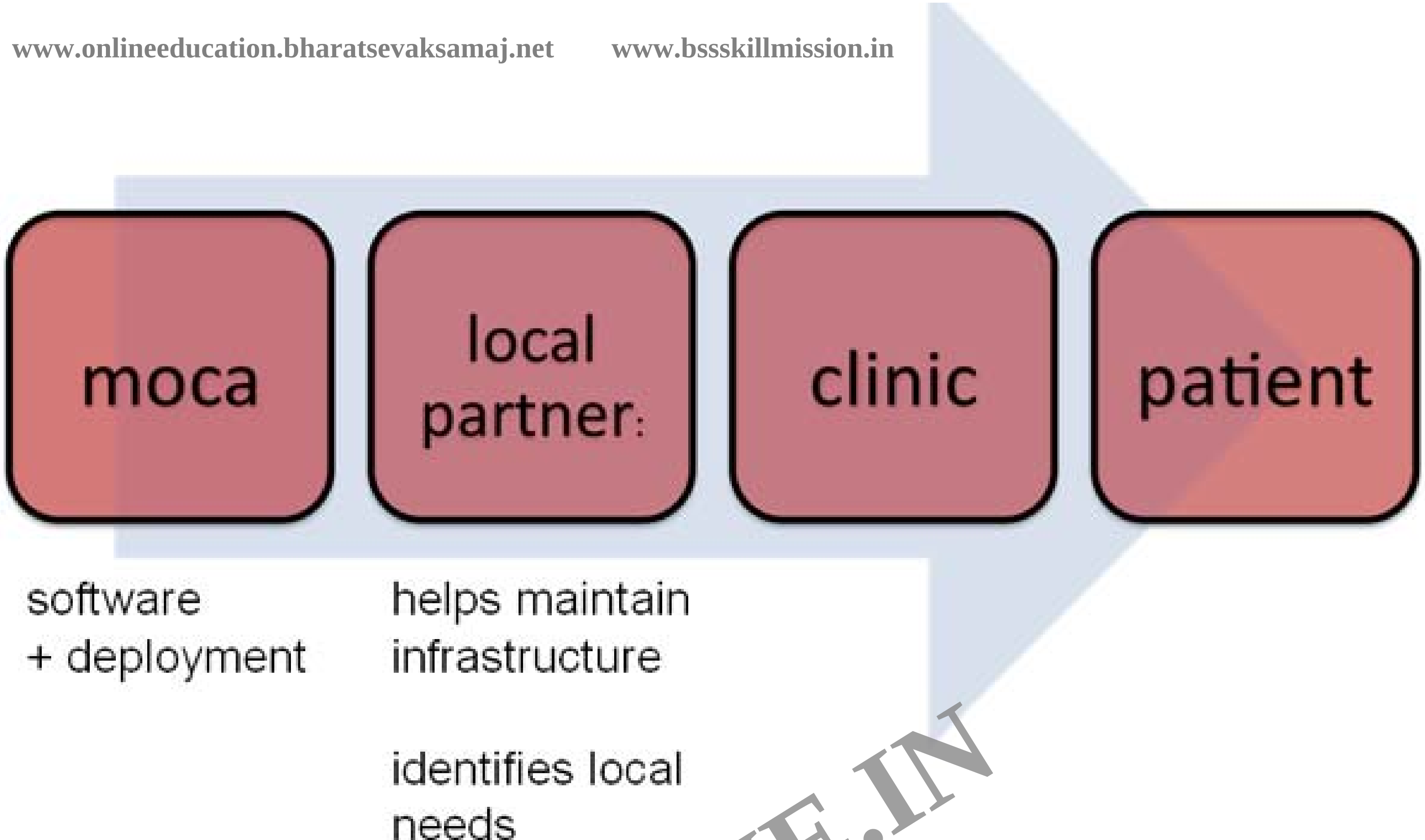
November 2008: initial local presentation
January – March 2009: planned travel to Philippines for prelim work and assessments
May 2009: pilot study deployed in Capiz : ophthalmology + dermatology

deployment

pilot study costs are fully covered through support from the **WHO** and the **Filipino Department of Health**

startup cost: $1200 (server)+ $200-$400 per phone

running cost: $0 - $100 per phone, month



open source software platform means low cost of deployment, no proprietary data formats, re-use of code and sharing of expertise

mocamobile.org

Development:
Clark Freifeld
Two anonymous MIT students
RJ Ryan

Operations/ Sustainability:
Santiago Alfaro
Ted Chan
Sameer Hirji
Crystal Mao

Media/ Communications:
Elliot Higger
Nicole Prowell

Advisors:
Leo Celi
Gari Clifford
Luis Sarmenta

MIT OpenCourseWare
http://ocw.mit.edu

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Mobile Diagnostics for Cervical Cancer

Milestone 1: Elevator Pitch & Background Research

Santiago Alfaro, Ted Chan, Clark Freifeld, Sameer Hirji, Crystal Mao

Cervical Cancer in Zambia

Source: CIA World Factbook.

•80% of new cases and 80% of the annual deaths occur in women who live in developing countries.

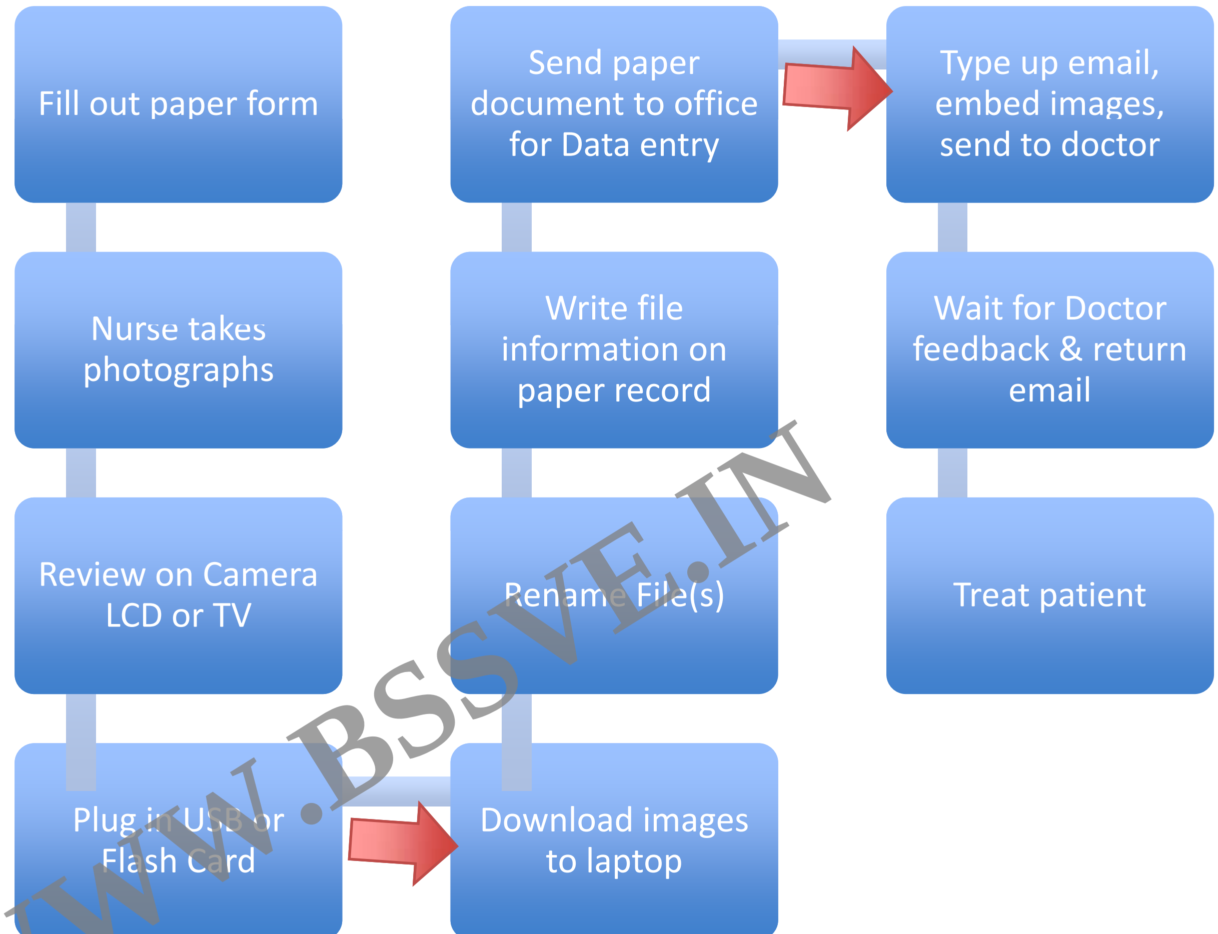
•Projected #1 killer of women in Zambia

•Clinics have screened 30,000 women in the past 2.5 years. There are 4.5 million women who SHOULD be screened in Zambia alone. **How do we scale this up?**

Elevator Pitch

- ZamMoCa is a mobile-linked web application that allows doctors to remotely diagnose and recommend treatment for cervical cancer patients via images.
- Unlike the current email based system, our solution will function under low network reliability and support both mobile and laptop input into a Flickr-like web interface. Centralized experts can then review, comment and make diagnoses based on the images.

Current Process

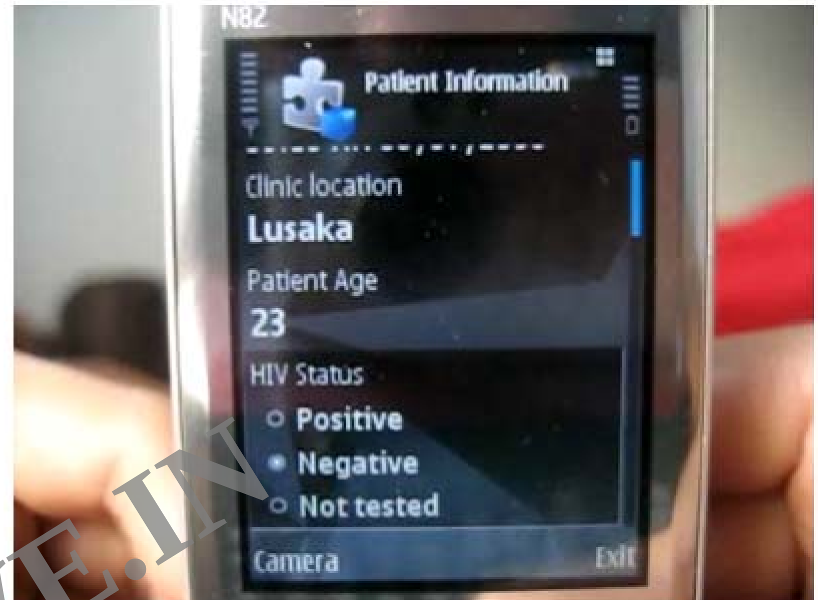


Room for Improvement

- Too many steps in current workflow
- Paper based data system is not incorporated with the electronic format
- Cell network connection in Zambia is spotty for reliable image transmission.
- Email image review is cumbersome, difficult to consolidate feedback

Last semester

- Functioning prototype
- Field tested by Andrés, Leo and Dan



- Limitations remain:
  - Low bandwidth
  - Excessive user confirmation
  - Camera quality lower than existing solution
  - Can only handle one image at a time
  - Bare bones web interface

next billion network

Our Solution

Courtesy of OpenMRS. Used with permission.

- Image capture, review, and enter patient record via camera+laptop or mobile device
- Wireless upload onto Open MRS web application
- Await doctor feedback

Other related projects

- **Diagnostics for All**: Last year's 100K winners!

Paper based microfluidic chip that changes colors when exposed to bodily fluids.

Allows for quick & easy diagnosis!

Courtesy of Diagnostics for All. Used with permission.

- **D-Tree**: Provides medical decision trees on PDAs
- **Voxiva's CareNet**: allows doctors to monitor patients' symptoms via SMS; provides reminders to patients to take pills, come in for treatment

Questions / Feedback?

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http://ocw.mit.edu

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MOBILE DIAGNOSTICS FOR CERVICAL CANCER

MILESTONE 2: NEEDS ASSESSMENT

Santiago Alfaro, Crystal Mao, Ted Chan, Clark Freifeld, Sameer Hirji

Cervical Cancer in Zambia

- ✓ Increasing at an alarming rate
- ✓ #1 killer of women in Zambia
- ✓ Approximately 30,000 women have been treated in the last 2 years out of 4.5 million

WHAT HAS BEEN DONE SO FAR?

Map: CIA World Factbook

FOCUS AREAS FOR SURVEY

DATA INPUT

- USER-FRIENDLY DEVICE
- RELIABILITY OF EQUIP
- EASE OF DATA COLLECTION

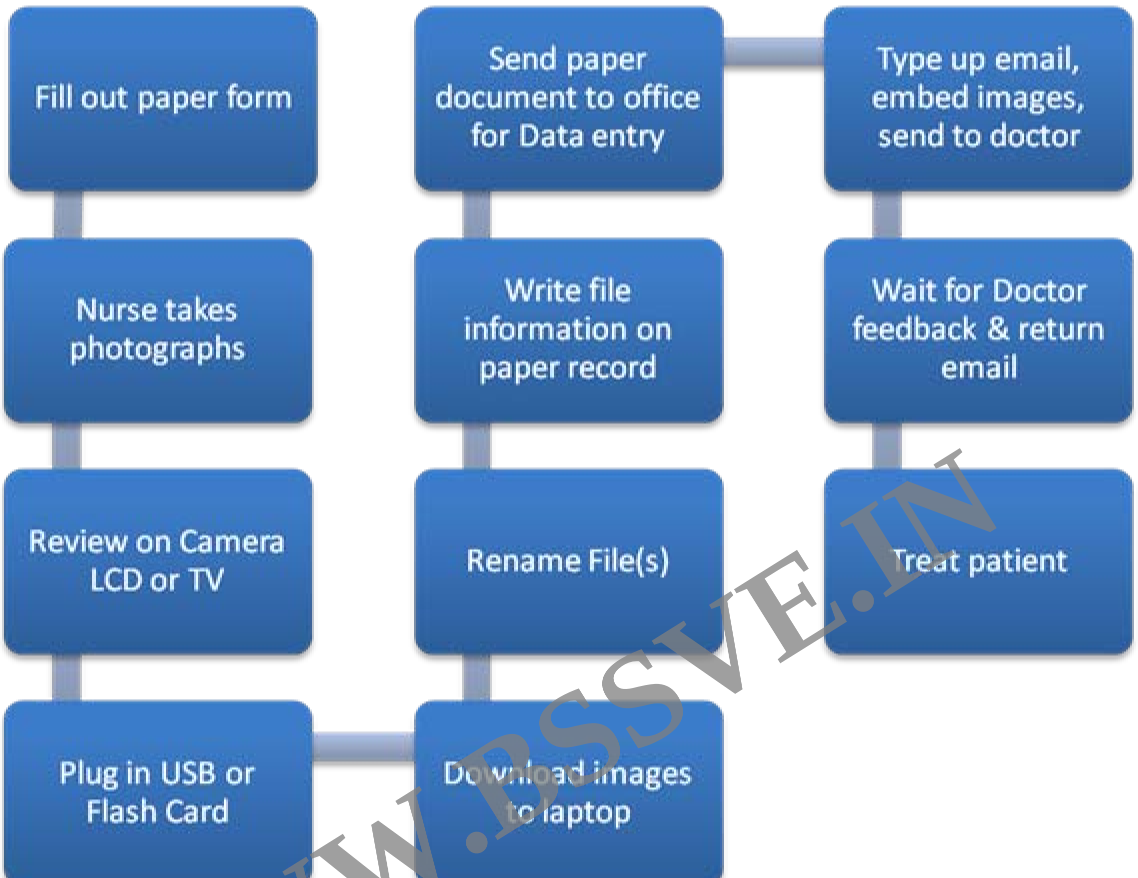
DATA PROCESSING

- UPLOADING IMAGES
- INFO. STORAGE AND ACCESS
- CONNECTIVITY
- EFFICIENCY OF WORKFLOW

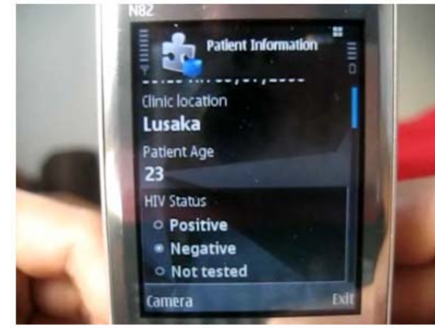
OUTPUT/ FEEDBACK

- DIAGNOSIS PROCEDURE
- FEEDBACK TIME/ RESULTS
- PRIVACY OF MEDI CAL RECORDS
- **SUSTAINABILITY ???**
- **SCALABILITY???**

CURRENT PROCESS FLOW



PRESENT STATUS



- Solution is COMPLEX
- Low bandwidth (spotty connection in Zambia)
- Functioning prototype tested has excessive User Confirmation (Lengthy, annoying)
- Nurses sufficiently satisfied with current image quality. e.g. Olympus camera 7 MP
- Restriction to single image capture and transmission at a time

- Patient-ID-to-image indexing and matching currently done in a paper-based system
- Work flow is complicated, slow
- 11 pilot clinics but very few trained nurses
- Cell phones are extensively used
- Only 3 medical doctors at CIDRZ
- **Small patient population** reached

WHAT INFORMATION WE NEED?

SAMPLE QUESTIONS…..

FOR CIDRZ

- Sources of Funding? What's the Budget?
- How is population being reached? Campaigns? Ads?
- Long term goals? Sustainability initiatives?

FOR NURSES

- Time spent during process? Current Challenges?
- Clinical Process description? How many images at a time?
- # patients per day? Per hour?
- Specialization of roles?
- Patient follow ups?

FOR DOCTORS

- Feed back Mechanism?
- # patients diagnosed per day? Time spent on 'call'?
- Process workflow? Improvements?
- Effectiveness of Image Quality?

- Must get **IRB approval** to conduct the surveys!
- Working with partners in Zambia to deploy surveys (paper form)
- Conduct more intensive in-person interviews if members travel to Zambia
- Language is not an issue b/c English is the official language.

Other Sources of Volunteers:

- Community based healthcare workers e.g.
  - Lusaka family health trust
  - Bwafwano community organization
  - Churches health association of Zambia.
- Medical Students from University e.g UNZA university

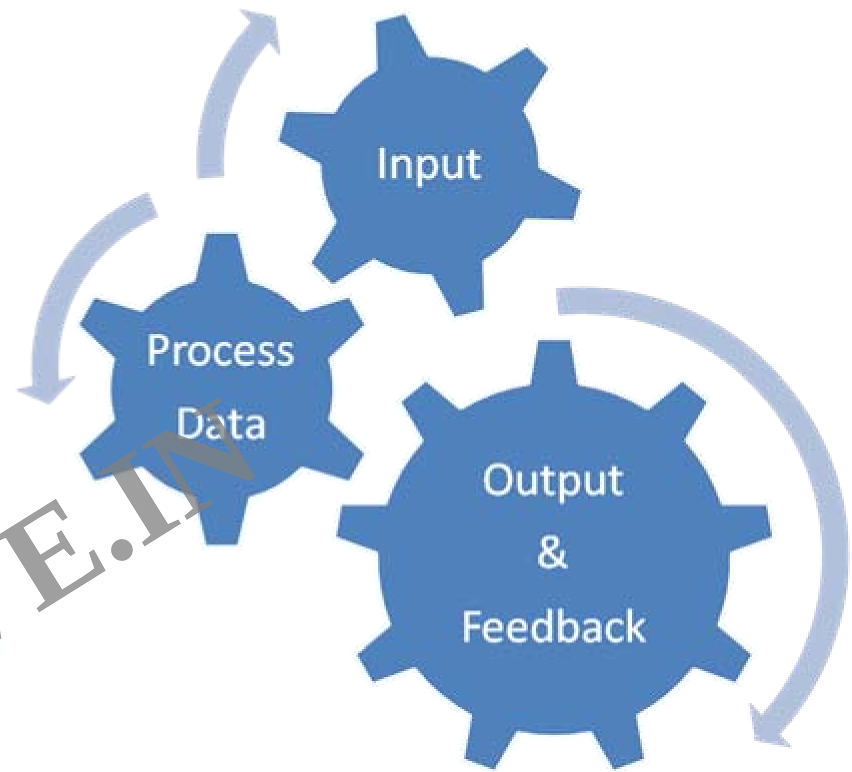
Mobile Service Providers

- MTN, Cell Z, CELTEL are Main MSP's
- The GPRS mobile Internet service was launched by CELTEL in late 2006 and covers all areas in Zambia where CELTEL operates.
- The access speed ranges from 30 to 160 kbps. To use GPRS one needs to have a PC-card (ZMK 950,000) or USB-card (ZMK 1,170,000).
- Cost of usage are ZMK 1,600/ MB and one can also purchase bundles of 100 MB for ZMK 85,000
- Post paid 1,600/MB Pay at the end of the month based on usage in MB

Proposed Improvements

Courtesy of OpenMRS.
Used with permission.

Simplified Version



Questions/ Suggestions!

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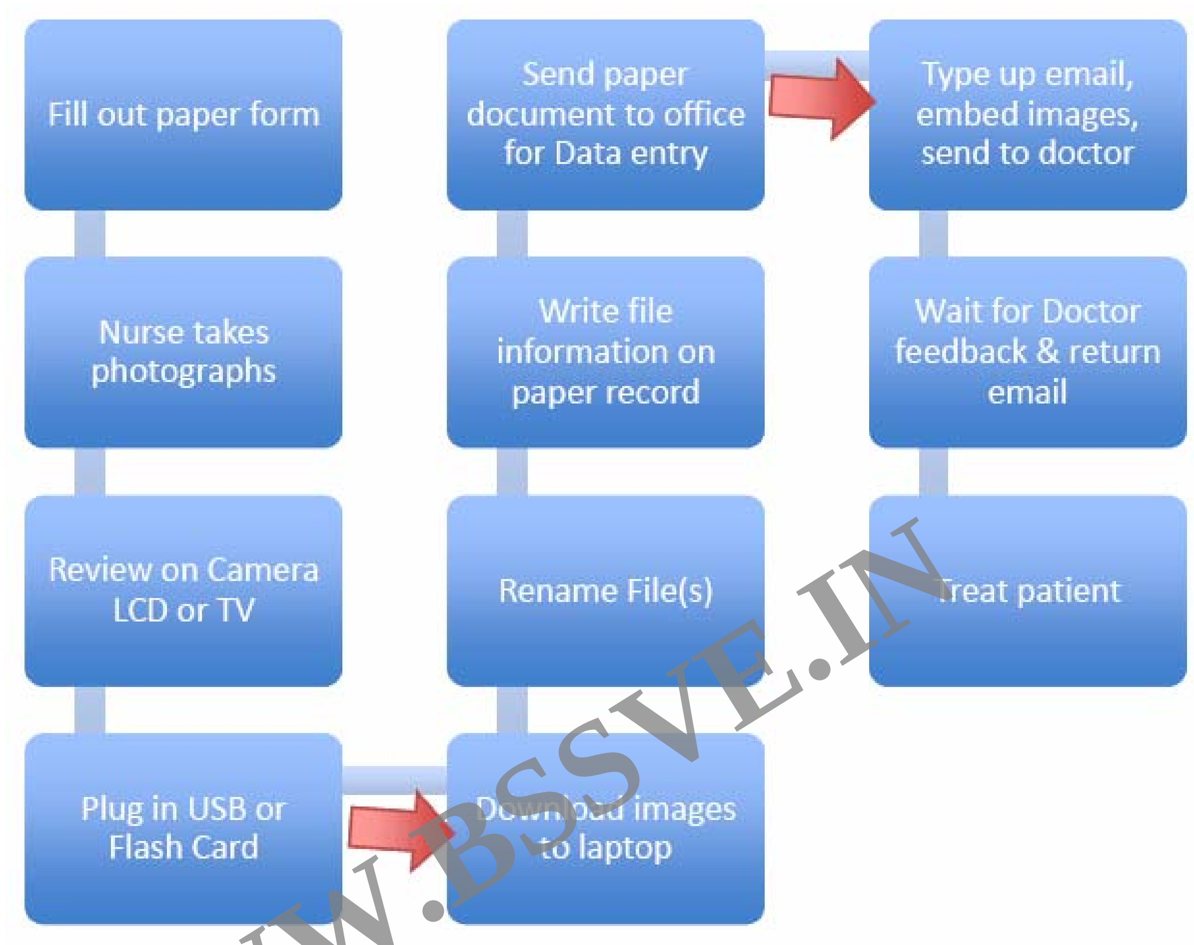
Mobile Diagnostics

for Cervical Cancer Screening in Zambia

Milestone 3: Initial Design

- Presentation: Clark Freifeld
- Team members: Santiago Alfaro, Sameer Hirji, Crystal Mao, Ted Chan
- Collaborators: RJ Ryan, two anonymous MIT students
- Faculty Advisor: Gari Clifford
- Local Liaison: Dan Myung

Current Process



Requirements

- Rapid, easy to use: high throughput
- Scalable beyond CIDRZ clinics
- High-quality photography
- Operate under low network bandwidth, reliability
- High-quality client-side image review
- Integrate with existing systems and procedures
- Ready to deploy in short term
- Sustainable in long term

Architecture

Courtesy of OpenMRS. Used with permission.

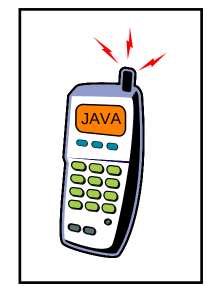
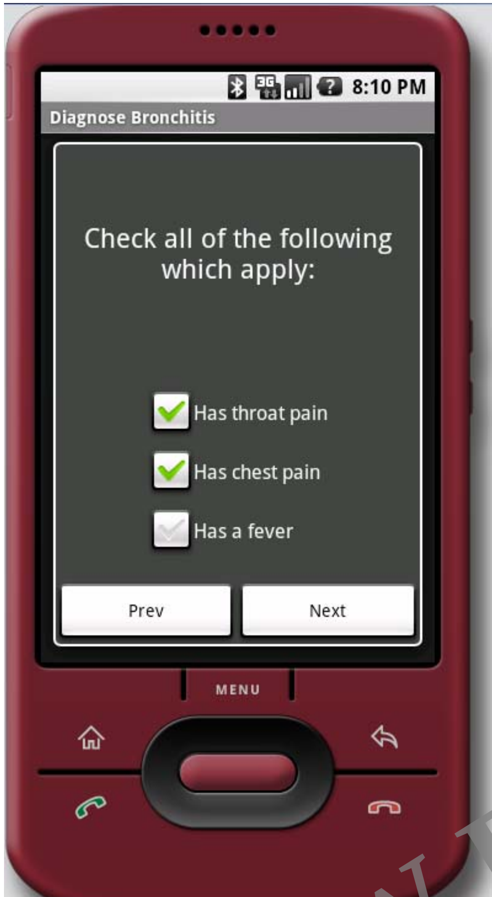


Figure by MIT OpenCourseWare.

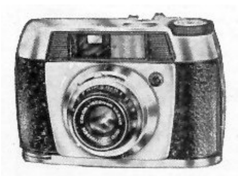
Android Solution

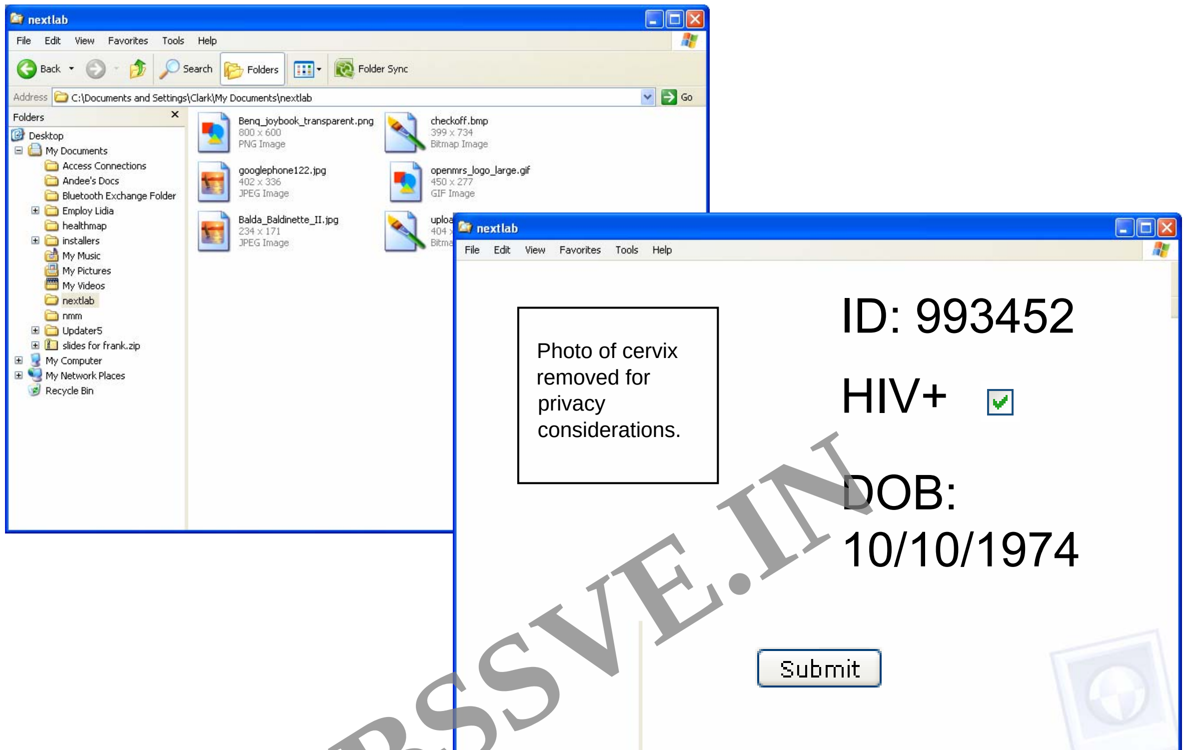


Requirements

- ☑ Rapid, easy to use: high throughput
- ☑ Scalable beyond CIDRZ clinics
- ☒ High-quality photography
- ☑ Operate under low network bandwidth, reliability
- ☒ High-quality client-side image review
- ☑ Integrate with existing systems and procedures
- ☒ Ready to deploy in short term
- ☑ Sustainable in long term

Laptop Solution





Requirements

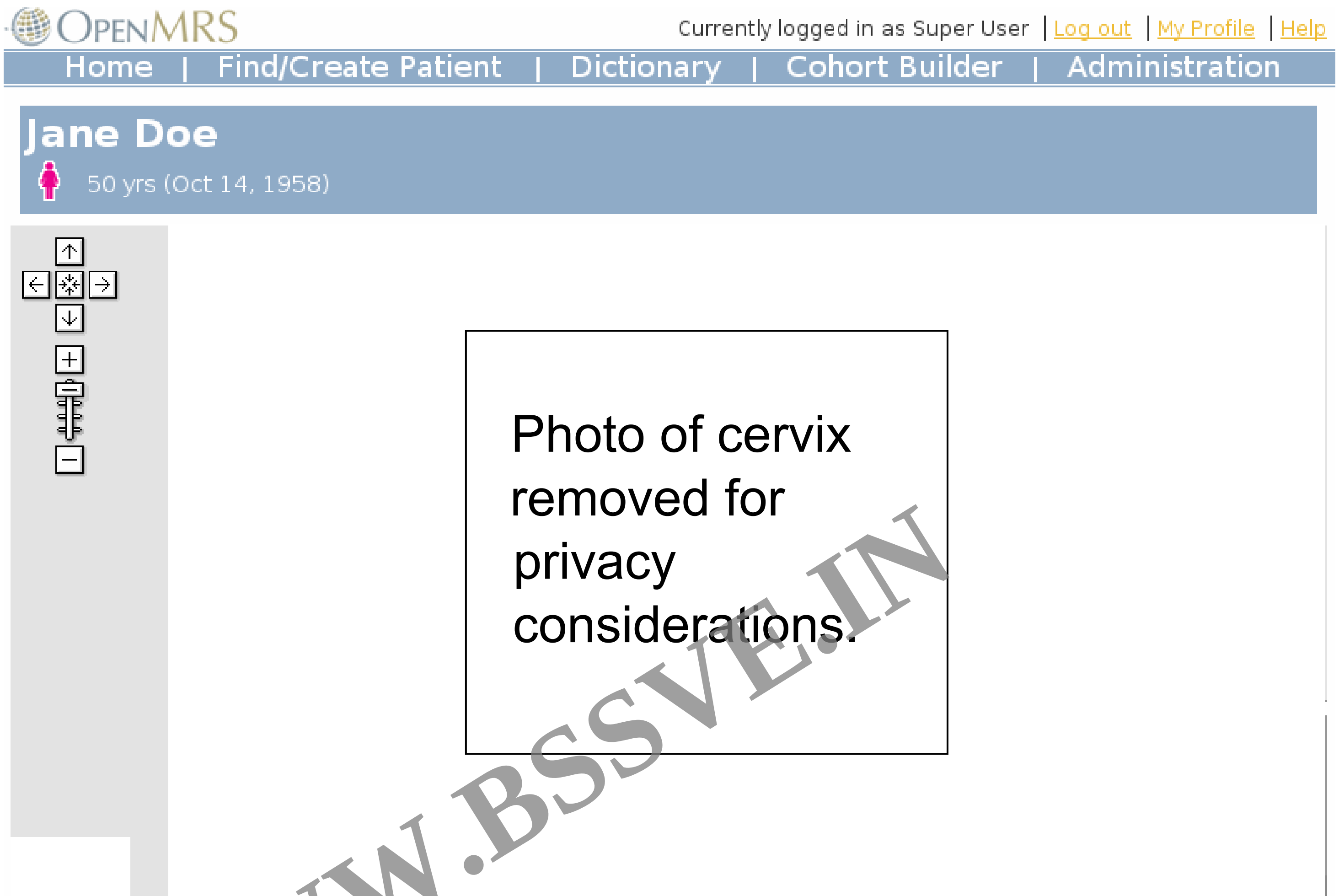
- ☒ Rapid, easy to use: high throughput
- ☒ Scalable beyond CIDRZ clinics
- ☑ High-quality photography
- ☑ Operate under low network bandwidth, reliability
- ☑ High-quality client-side image review
- ☑ Integrate with existing systems and procedures
- ☑ Ready to deploy in short term
- ☒ Sustainable in long term

J2ME Solution

Requirements

- ✓ Rapid, easy to use: high throughput
- ✓ Scalable beyond CIDRZ clinics
- ✗ High-quality photography
- ✗ Operate under low network bandwidth, reliability
- ✗ High-quality client-side image review
- ✓ Integrate with existing systems and procedures
- ✓ Ready to deploy in short term
- ✓ Sustainable in long term

OpenMRS Server



Web interface screenshots courtesy of OpenMRS. Used with permission.

Requirements

- ☑ Rapid, easy to use: high throughput
- ☑ Scalable beyond CIDRZ clinics
- ☑ High-quality photography
- ☑ Operate under low network bandwidth, reliability
- ☑ High-quality *image review*
- ☒ ☑ Integrate with existing systems and procedures
- ☒ Ready to deploy in short term
- ☑ Sustainable in long term

Conclusion

- Current focus is on Android + OpenMRS
- Possibility for laptop solution + J2ME improvements

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Mobile Diagnostics

for the next billion

Milestone 4: Sustainability

- Presentation: Santiago Alfaro
- Team members: Clark Freifeld, Sameer Hirji, Crystal Mao, Ted Chan
- Collaborators: RJ Ryan, two anonymous MIT students
- Faculty Advisor: Gari Clifford
- Local Liaison: Dan Myung

Big Changes

- Open Source Software project
- Not site specific.
- Not treatment specific.
- Not Organization Specific
- The creation of an expert

labeled database that allows:

  - Quality auditing and cost controls
  - Rapid search and review
  - Automatic classification of images
  - Local training of nurses using cell phones

Financial

Short Term

- Grants
- Corporate funding
- Integration and training services

Long Term

- Database management
- Work through organizations (PIH, CIDRZ, CRS, governments, private clinics, etc) that can afford the equipment and our support service.
- Google, HTC or other corporation might donate equipment

Technological

Courtesy of OpenMRS. Used with permission.

- Integrated with OpenMRS for portability
- Generic system that will work for all videos, audio and imagery
- Smartphone is required but the system is certainly open to other platforms (iPhone, Symbian, etc)

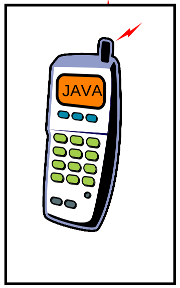

Figure by MIT OpenCourseWare.

Human

- Focus on patients and different conditions
- Multiply the amount of healthcare providers
- By treating more people with a wider range of conditions, we will ensure the survival of the service.

Operational

- Open Source projects can be maintained on a volunteer basis.
- Dynamic and Customizable
- Open MRS to ensures a seamless interaction with other systems.

Thank You

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Project "Get New Money"
Multi-Level Marketing for Microfinance

MIT Team Members: Three anonymous MIT students

Emerson Team Members: Helyne Adamson, Josh Kirchmer

Team Adviser: Elisabeth Megally

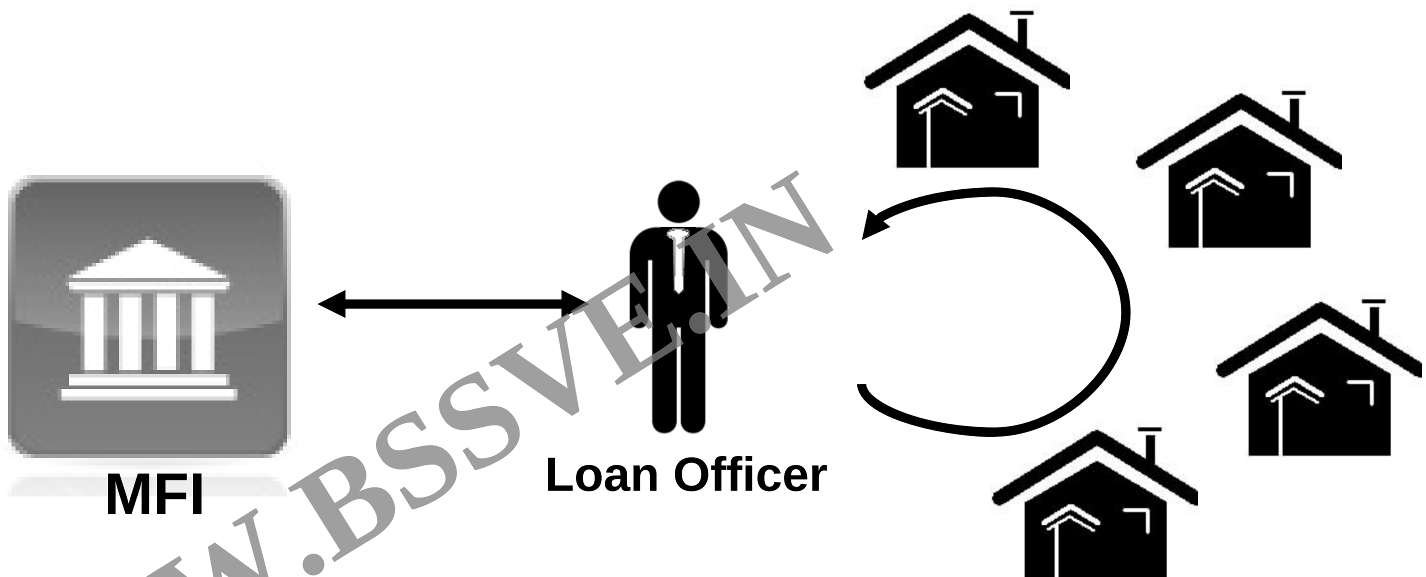
Next Lab : Public Presentation **December 10th, 2008**

Revolutionize Micro-Finance industry with Multiple-Level Marketing

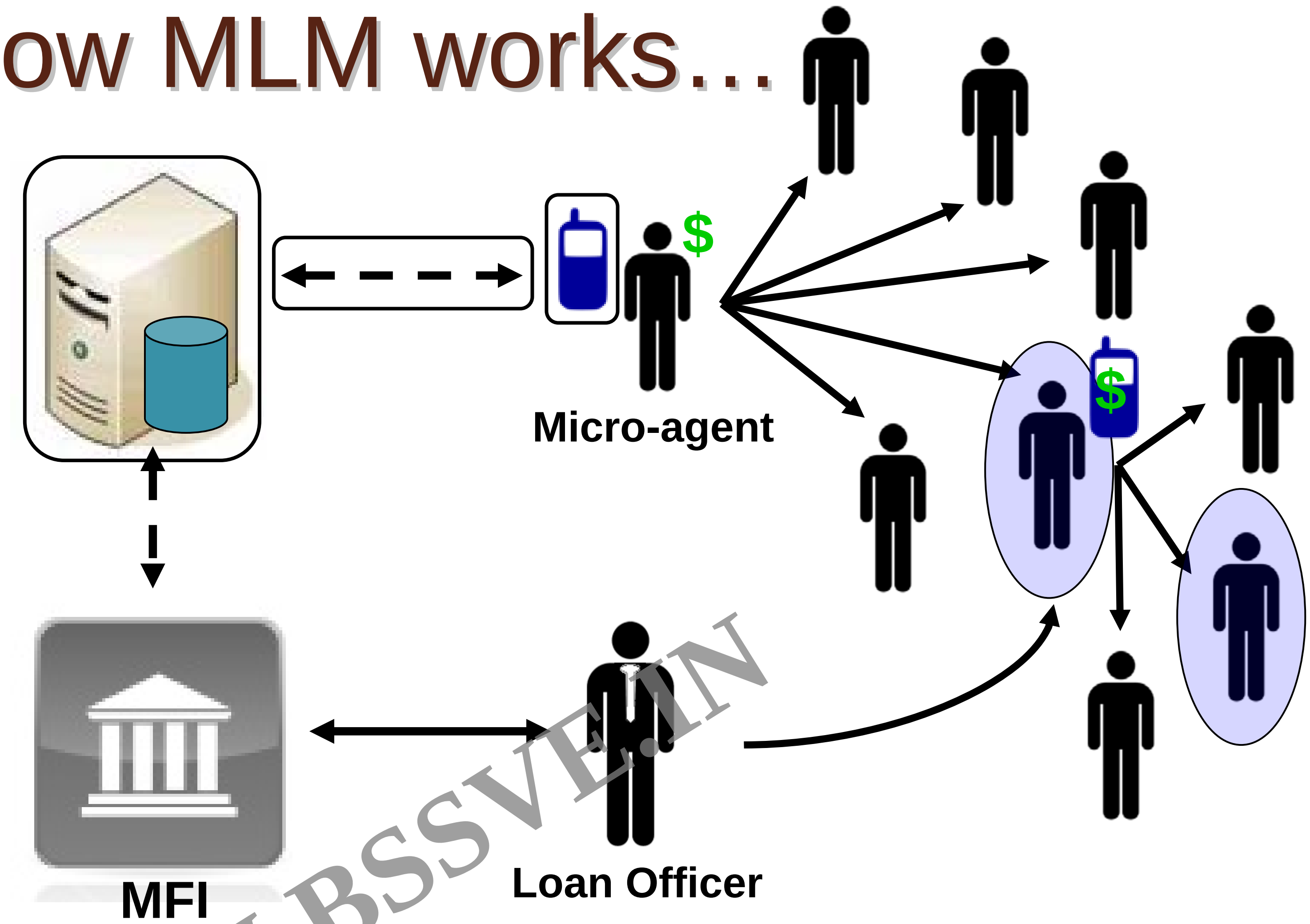
- Goal: Rapid expansion of micro-finance outreach
- Team Deliverables:
  - Business model on how Multiple-Level Marketing would work with Micro-Finance
  - Mobile-based application to help facilitate and streamline the process
- Partner: Cobis, a financial software company, the original idea owner
- Pilot: Maquita, Ecuador

Map: CIA

How it currently works...

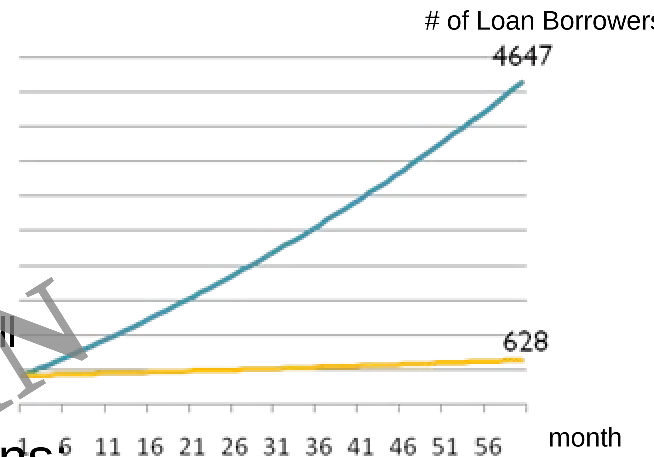


How MLM works…



MLM can significantly improve micro-finance institution profit

- Maquita (MFI partner) currently offers fixed-rate micro loans
- MLM can help improve market adoption rate and generate strong revenue/profit growth
  - If a micro-agent brings in a borrower a month, within 6 years, it will have 7.5x more borrowers than the case w/o MLM.
  - More borrowers means more revenue
  - More borrowers also reduces the overall risk of the loan portfolio



- Additional improvement suggestions:
  - Returning borrowers have much higher payback rate than new borrowers
  - Encourages new loans by offering lower interests to repeating borrowers, who are also less risky, thus, create an exponential growth

How mobile phone application works...

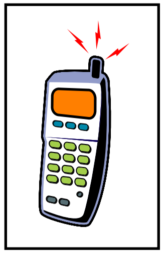


Figure by MIT OpenCourseWare.

SMS Communication Server

Encrypted and compressed proprietary SMS Communication

Mobile Phone Application
• Data collection
• Status reports

Database

Local Database

Figure by MIT OpenCourseWare.

Get New Money Server (Data Processing)

Hooks for
- Credit Scoring
- Integration with Cobis

Photos credit: msnbc.msn.com, peopledaily.com.cn

Video DEMO: Showing typical usage scenarios of the mobile application

- Creating new loan client
- Requesting new loan
- Checking loan status
- Checking for agent performance

Play DEMO

Beyond NextLab I ….

- Deliver a comprehensive business plan to Cobis and Bank of America partners
- Deliver technical solution with integration instruction to Cobis
- Ideas for Next Lab II
  - Extend the technical solution to be more generic
  - Actual pilot of the concept and technology

Thank you!

Backup: <DEMO screen shots to be added>

- Microagent meets a new potential borrower
- Takes phone out, takes client’s data and sends it over to the server
- Adds a loan to the newly created client
- Someone on the server side approves
- Agent sees change in loan status
- Agent sees his expected commission go up

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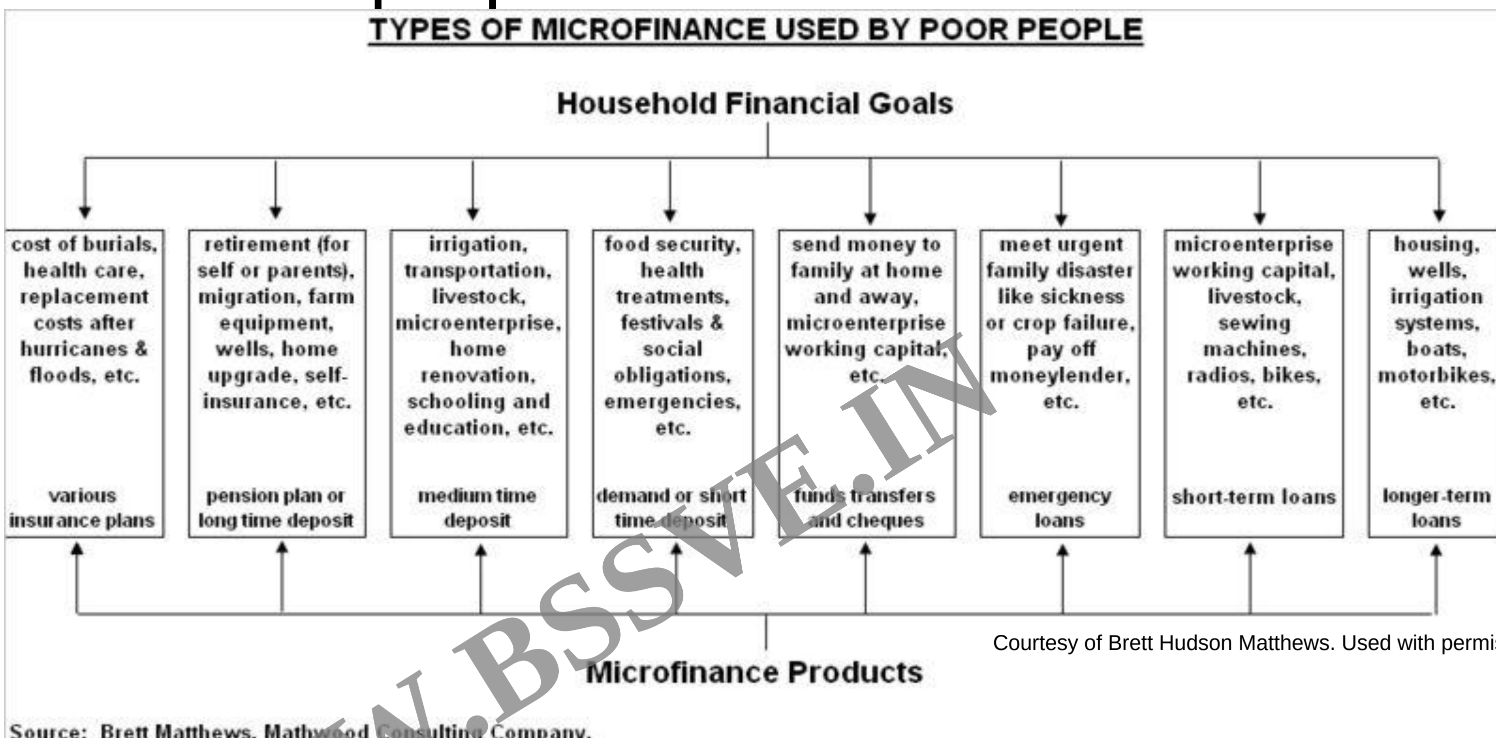
Enhanced Cellphone-based Multi-level Marketing for Microfinance

Microfinance

- Aims to provide financial services to low-income people



Courtesy of Brett Hudson Matthews. Used with permission.

Challenges & Multi-level Marketing

- The average loan amount is small, so it is expensive to service them
- In MLM, previous borrowers work as loan officers, collecting client data. It has offloaded the work to different levels and increased scalability

Current Cobis Solution

- Centralized client-server architecture
- Web-based application
- Require expensive handheld devices to browse internet
- Expensive mobile data charge
- Low market penetration rate, and slow progress in business development

Our Proposal

- Switch to a distributed architecture based on SMS communication
- Enable cheap handsets to be data-collection terminals
- Increase the number of "loan officers," give poor people better access to loan applications

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http://ocw.mit.edu

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Enhanced Cellphone-based Multi-level Marketing for Microfinance: (Milestone 2)

Feedback

- Technical Requirements
- Credit Scoring Process
- Compensation of Micro-Agent
- Next Step

Technicals

- What are the *majority* of cell networks capable of?
  - The solution has to be low tech, but MUST boost efficiency. If SMS is too inefficient, we will discard it.
- What is the guideline for our solution?
  - Option 1: Find the lowest (reasonable) common denominator across MFI business environments.
  - Option 2: Focus exclusively on the Maquita Cushunchic environment.

Credit Scoring Process

- We need to find out how micro-financing credit scoring works
  - If relatively simple, we use SMS.
  - If complex, we take the chance of rapidly improving access to technology, and build a web service that communicates with the phone through a J2ME application

Compensation

- Incentive should be based to a certain degree on effort, not just whether a client is profitable to the MFI or not.
- Micro-agent should be regarded as an income-augmentor, not a primary source of income.
- Suggestion: Flat-rate "goodwill" kickback to the agent the first time his customer makes a substantial transaction (deposit or loan) with the MFI.

Next Step

- Talk to Raul about access to servers/Cobis tech
- Talk to Bill about credit scoring company contact
- Talk to Marcial about Maquita Cushunchic investigation.
- Follow the discussion regarding compensation scheme

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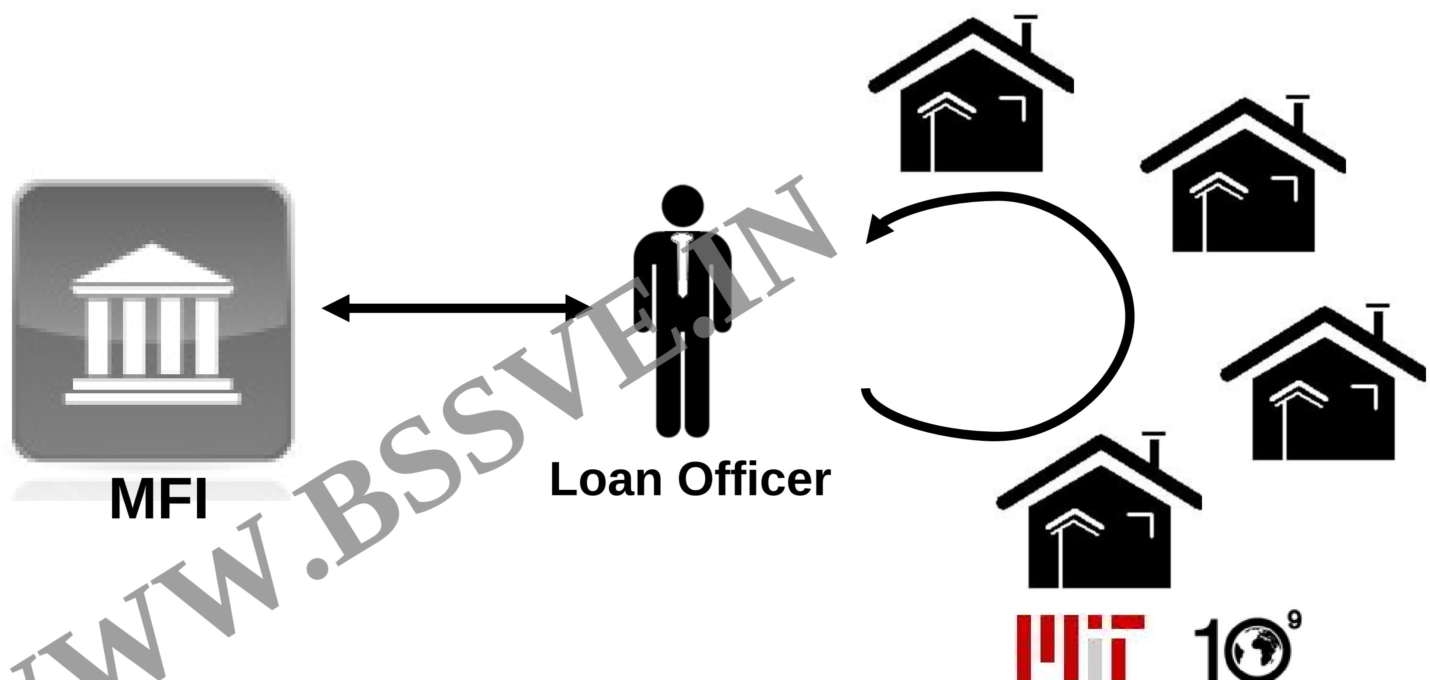
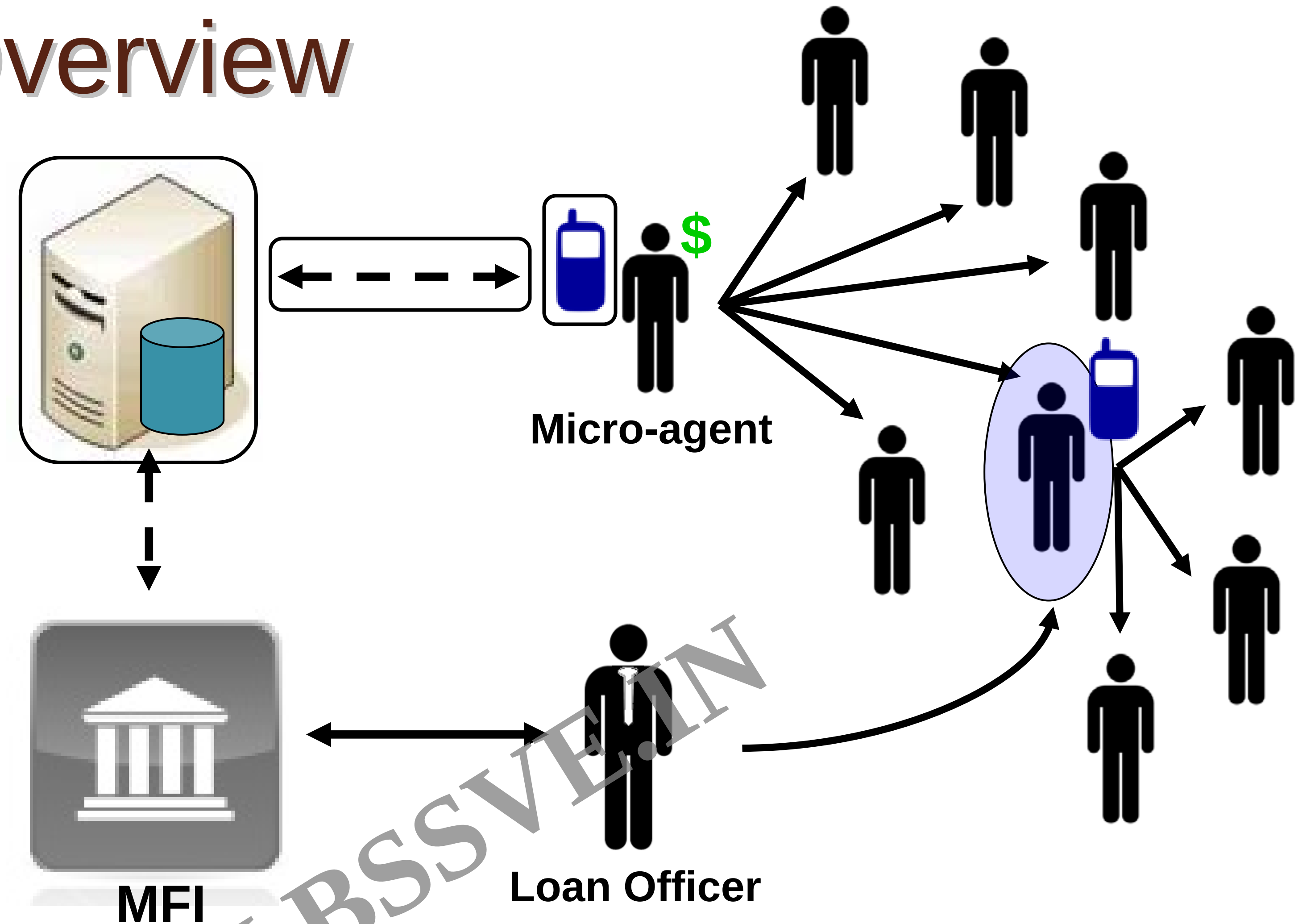
Get New Money: Multi-Level Marketing for Microfinance System Design (Milestone 3)

Adviser: Elisabeth Megally

Overview



Overview



Phone

- Data collection
- J2ME application
- Easy user interface
  - Assume some level of literacy in target users
  - Minimize typing

Use Cases

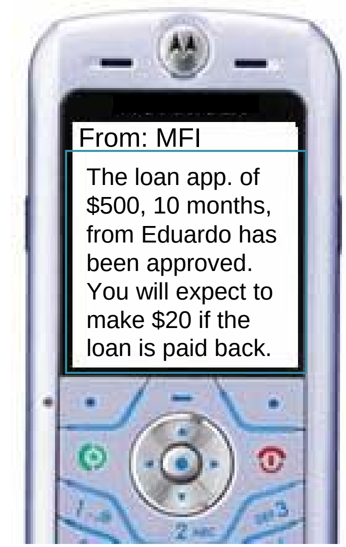
- Create/Edit user info
- Submit loan application
- Look up information

Use Cases

- Create/Edit user info
- Submit loan application
- Look up information

Use Cases

- Create/Edit user info
- Submit loan application
- Look up information



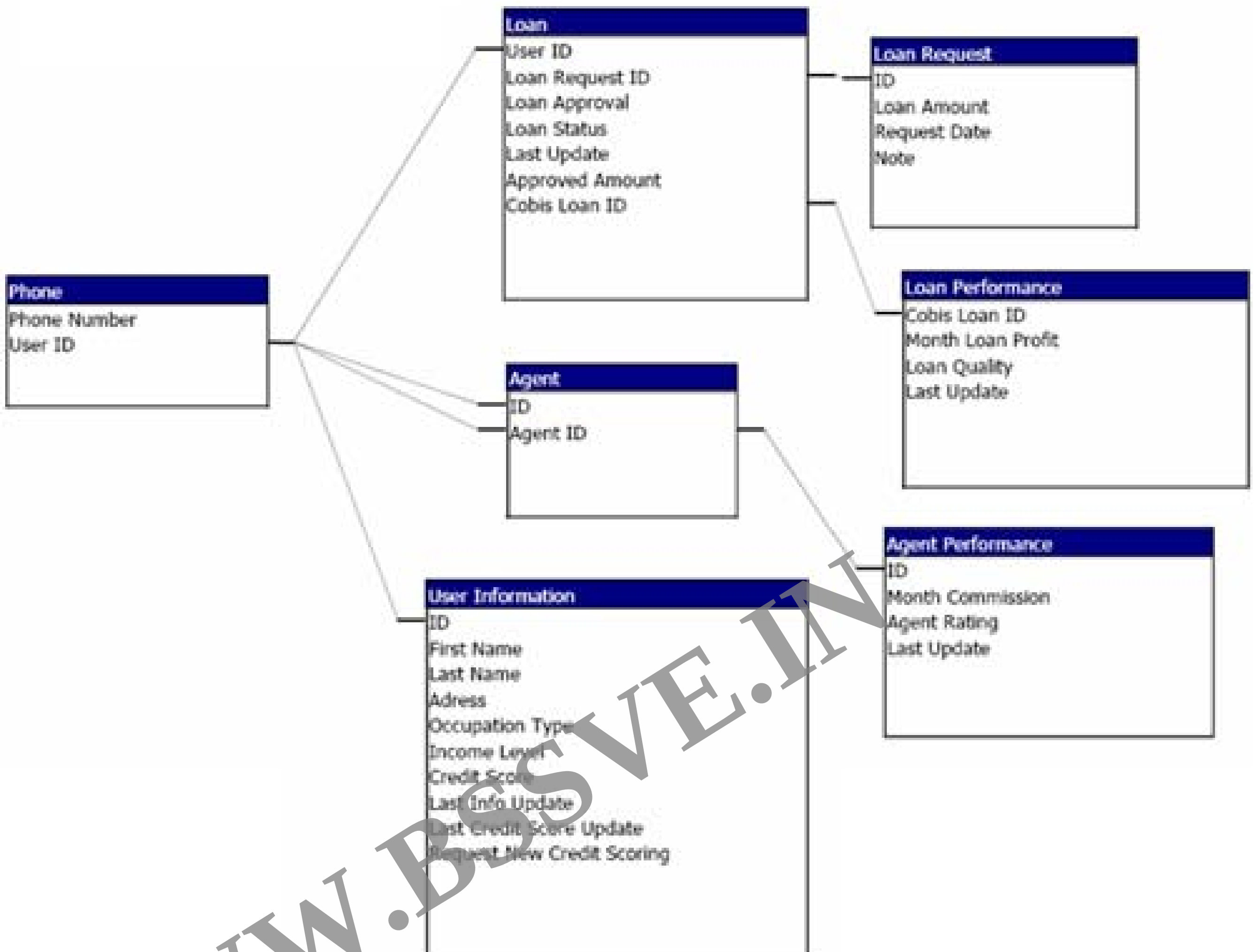
Use Cases

- Create/Edit user info
- Submit loan application
- Look up information

Server

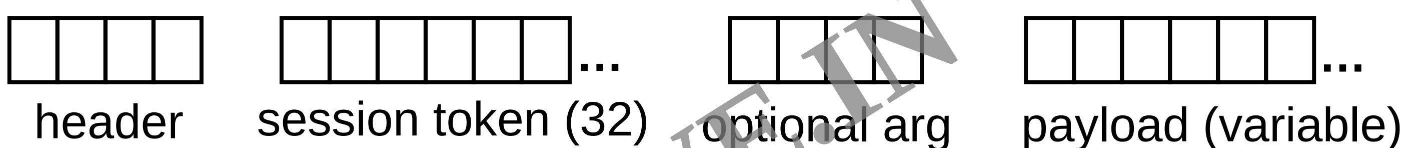
- Database
- Interface for MFI
  - Allow external queries
  - Push information to users

Database


Loan
User ID
Loan Request ID
Loan Approval
Loan Status
Last Update
Approved Amount
Cobis Loan ID
Loan Request
ID
Loan Amount
Request Date
Note
Phone
Phone Number
User ID
Loan Performance
Cobis Loan ID
Month Loan Profit
Loan Quality
Last Update
Agent
ID
Agent ID
Agent Performance
ID
Month Commission
Agent Rating
Last Update
User Information
ID
First Name
Last Name
Adress
Occupation Type
Income Level
Credit Score
Last Info Update
Last Credit Score Update
Request New Credit Scoring

Communication Protocol

- Text messages (SMS)
- Lots of information → many messages
  - Acknowledgements
- Security



Going Forward

- Timeline
  - 11/05: Database set up, basic phone app done
  - 11/12: Comm protocol, all phone app features
  - 11/19: Server/MFI interface (feature complete)
- Developers
  - Searching for UROP (still!!)
  - Looking into working with other teams
- Extensibility
  - Different forms
  - Interface for MFIs

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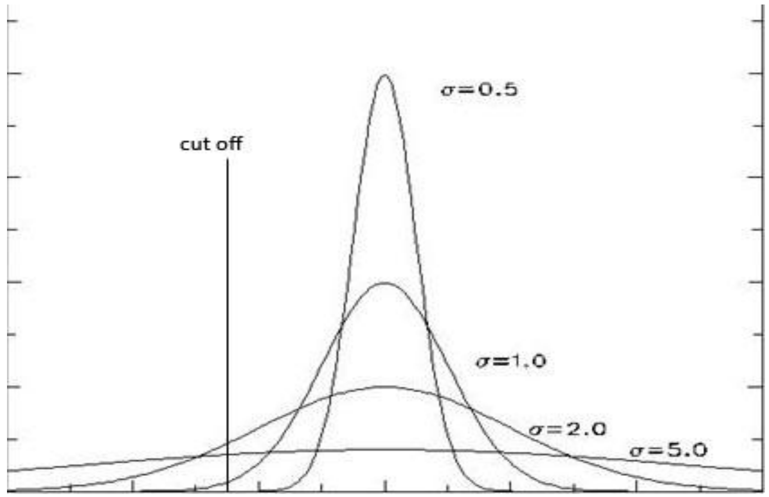
Enhanced Cellphone-based Multi-level Marketing for Microfinance (Milestone 4 - Sustainability)

Business Model

	Payback	APR
m0	45%	60%
m1	65%	40%
m2	75%	35%
m3+	89%	15%

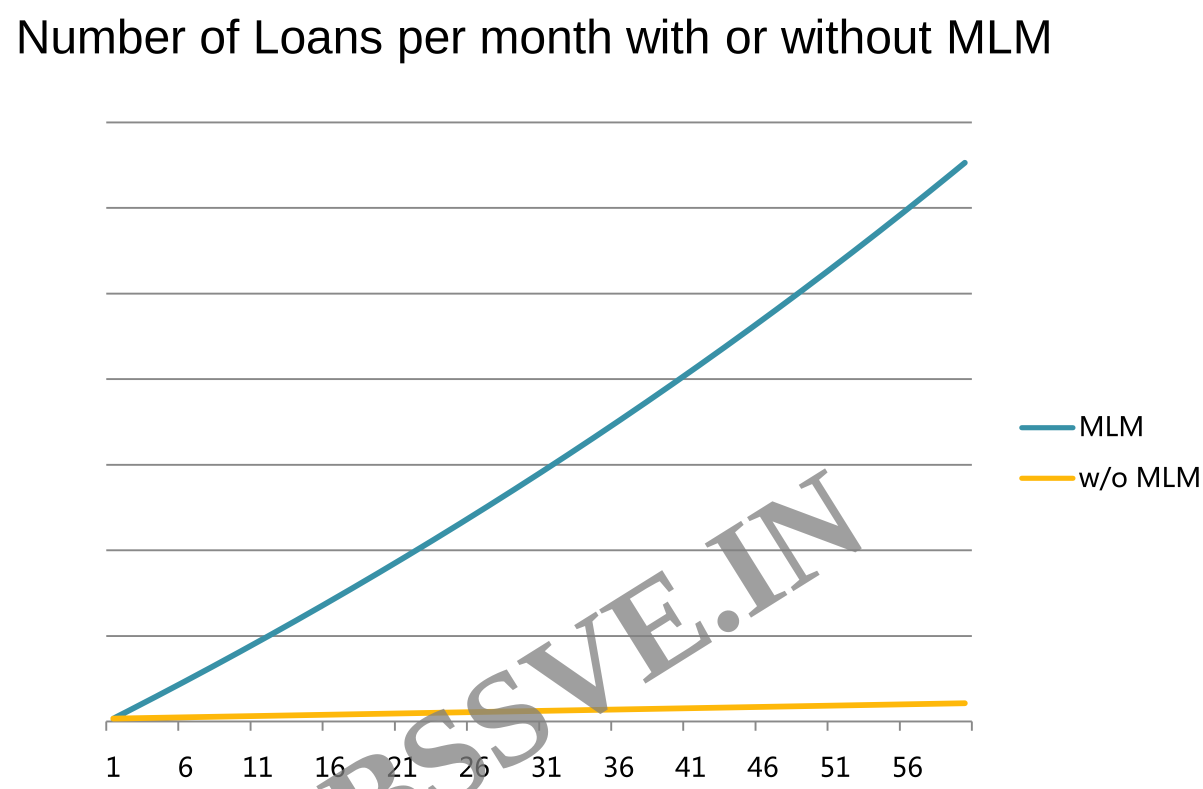
- Returning borrowers have much higher payback rate. When people borrow more than 3 times, their payback is similar to loans with collateral, while about half of the first time borrower cannot payback their loans at all
- MFI makes money from loan to returning borrower and subsidize the first time borrowers
- Attract new borrowers to have more returning borrowers.

MLM and MicroFinancing

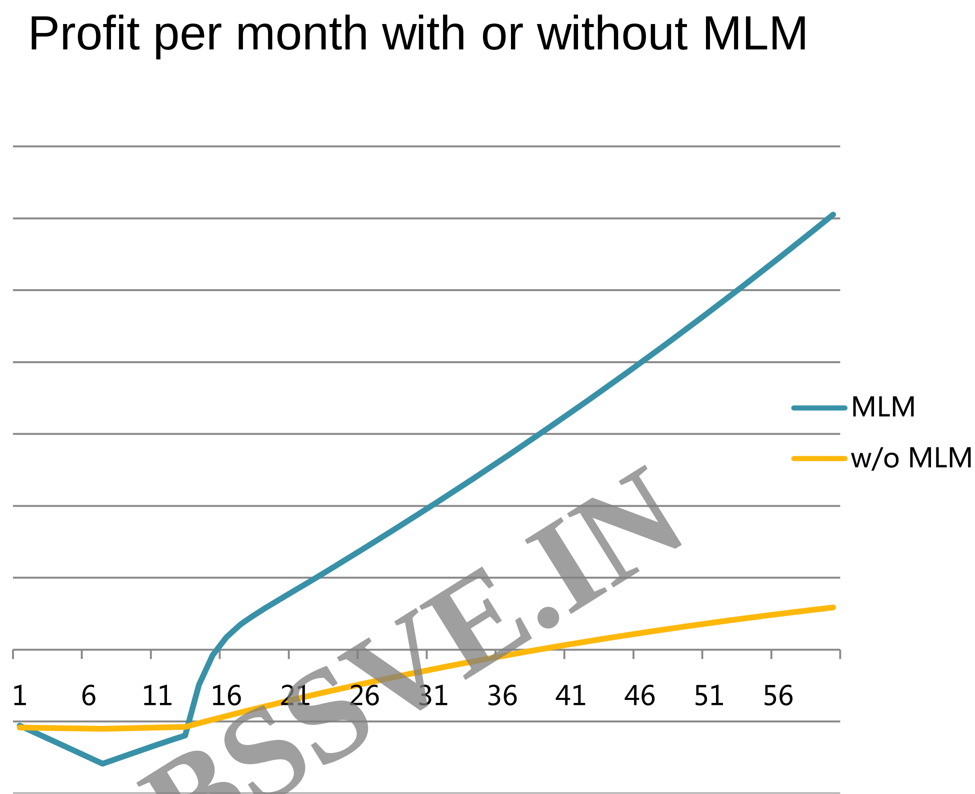


- The return of loan satisfies normal distribution
- The more data you have, the small the std dev $\sigma_{\text{mean}} = \frac{\sigma}{\sqrt{N}}$
- The cut off point is the minimum return that MFI wants to have to be profitable, if the original one is 2σ , it means that 97.73% of customer will payback your loan. When you have 100 times of more data, the cutoff point became 20σ , which increase the total payback rate significantly, almost everybody will payback the loan. So, you want to reach out to more customers
- MLM is an ideal solution

Faster Growth with MLM



Faster Growth with MLM



Keys for Sustainability

- When you have more data, you can do a better profiling for loan approval, and you will have a better estimation of the payback rate with lower variance. Then, you can lower the interest rates associated with the loan, which will further increase the payback rate. Meanwhile, by reaching out to more people, you significantly increase the N, and lower your overall risks.

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nextmap

nextlab event 2008

Designing Mobile Technologies for the Next Billion Users

Team

MIT:

Anonymous MIT student, **Sreya Sengupta, Vijay Umapathy, Jeffrey Warren, Oliver Wilder-Smith**

Emerson Media Team:

Nicholas Vaky, Maximilian Wagenblass

Advisors:

Rich Fletcher

Overview

Nextmap is a platform agnostic toolkit for mobile data collection, processing, and dissemination with initial applications in disaster management and environmental conservation.

Project Parters

InnovGreen

CATHOLIC RELIEF SERVICES
Giving Hope to a World of Need

Courtesy of Catholic Relief Services. Used with permission.

3 projects

CRS Questionnaire

Using off-the shelf solutions to fix the CRS cellphone-based survey.

For CRS representatives

CRS NextMap

Using SMS-based mapping to improve real-time communication and relief efforts in disaster situations.

For anyone in a disaster-prone area

InnovGreen

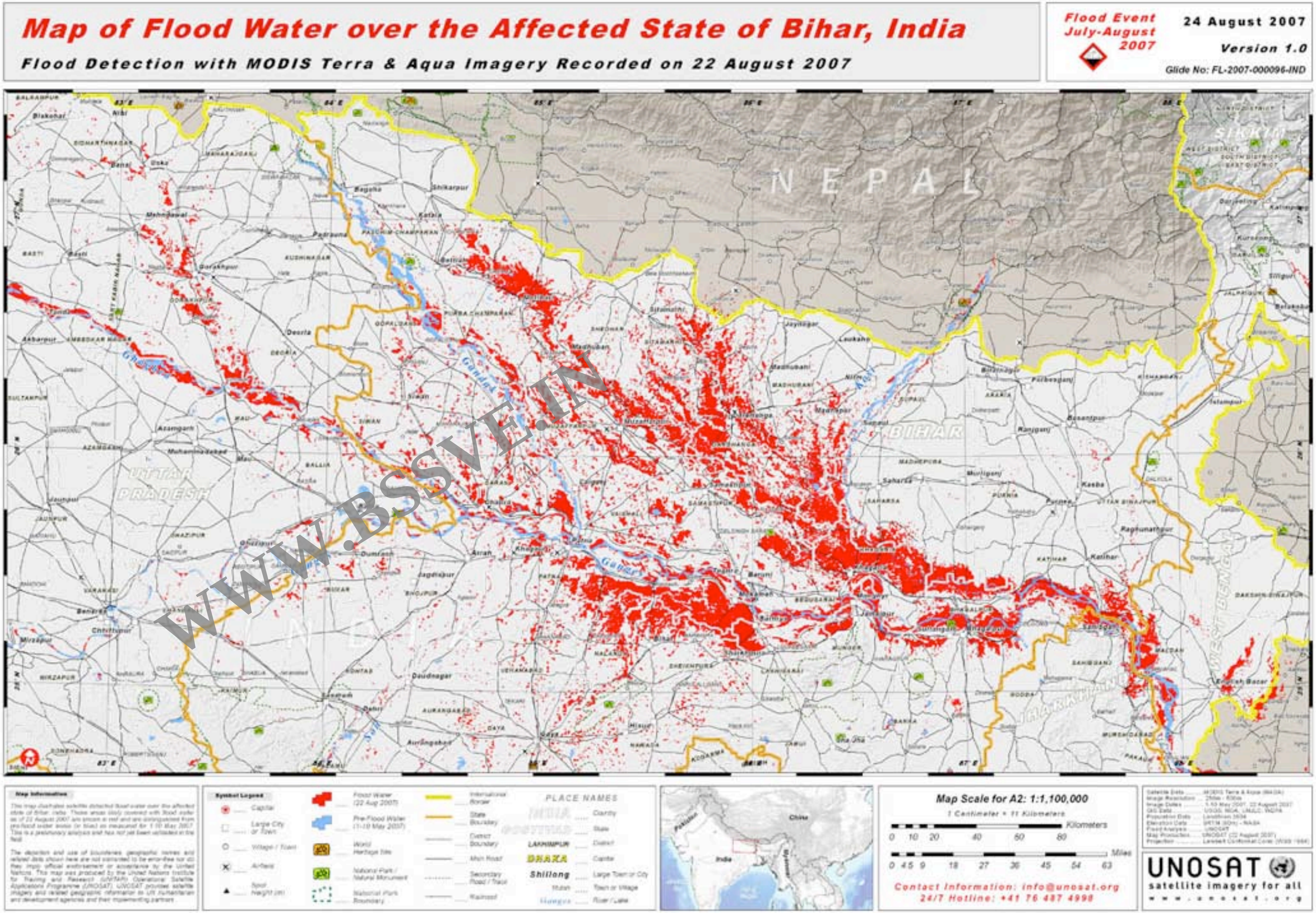
Using GPS and a Windows Mobile application to record Agent Orange-deforested areas for later analysis.

For InnovGreen employees

CRS: Bihar, India

CRS: 2,400 villages – 28k people across India

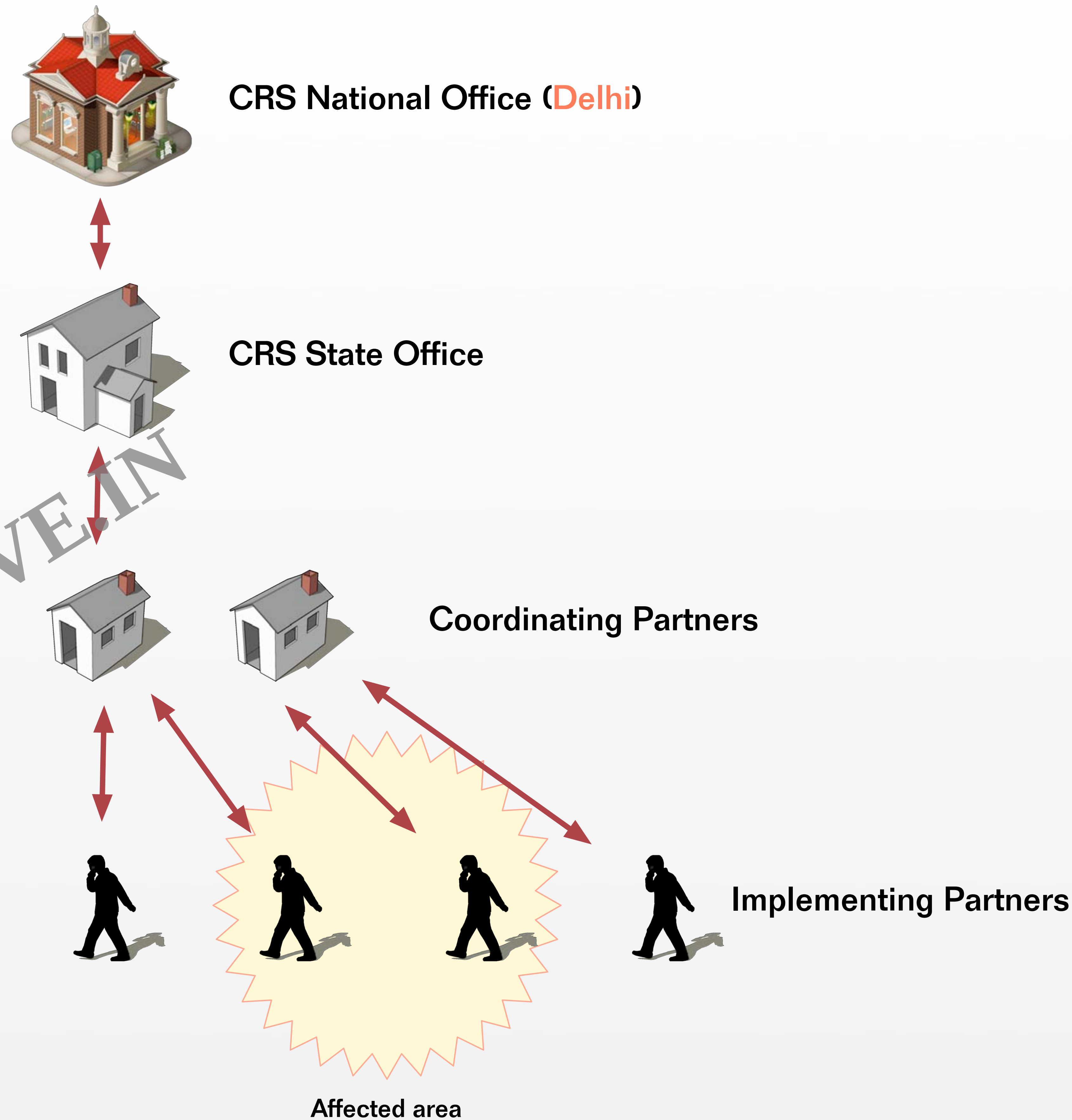
Map image removed due to copyright restrictions.

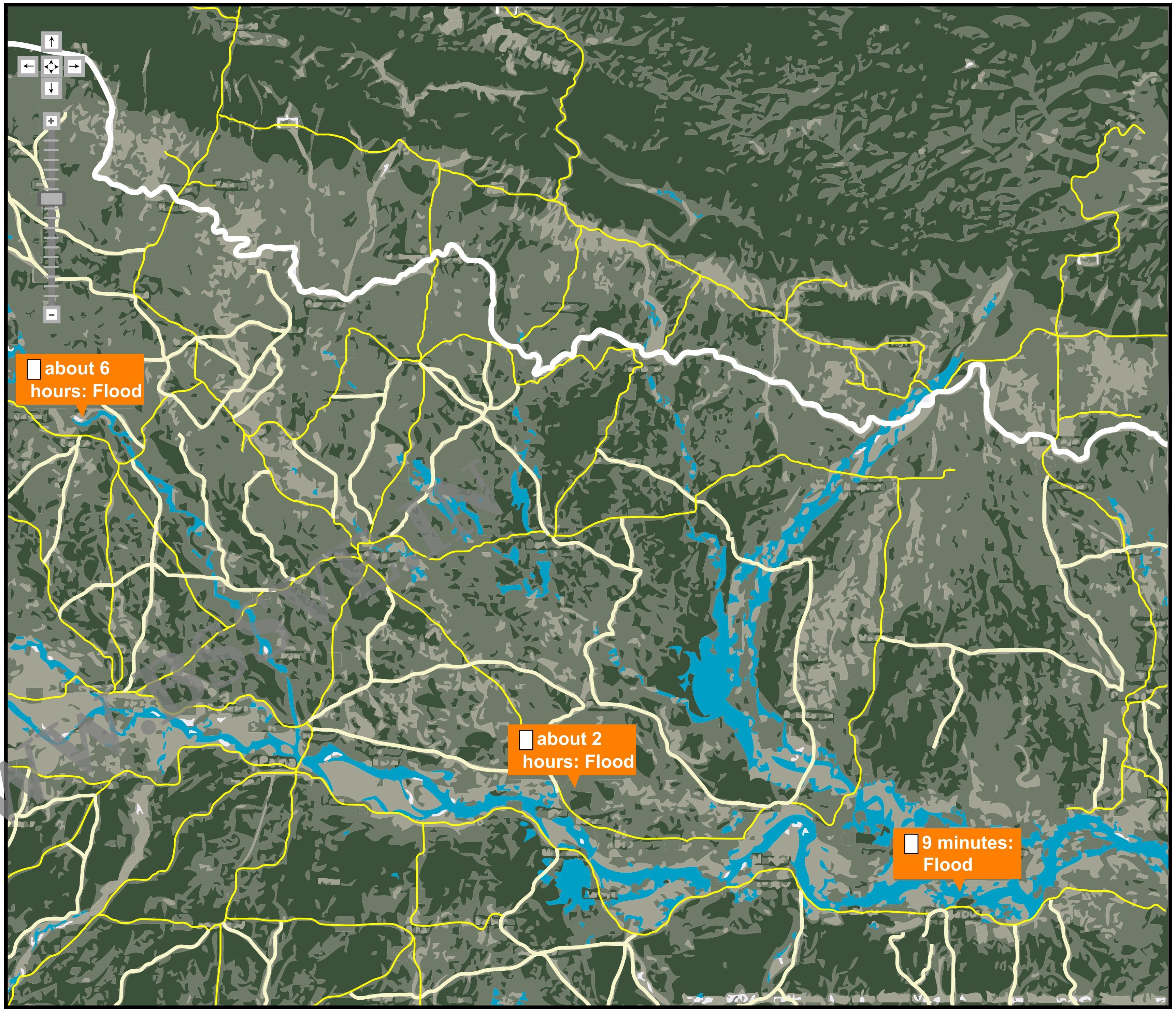


Courtesy of UNOSAT.
Map from http://unosat.web.cern.ch/unosat/asp/prod_free.asp?id=84.

CRS Need

Currently paper-based communication takes 1 month for information to reach central office, and deploy response





Map by MIT OpenCourseWare, substituted for a Google Maps image.

nextmap.media.mit.edu

Existing solutions

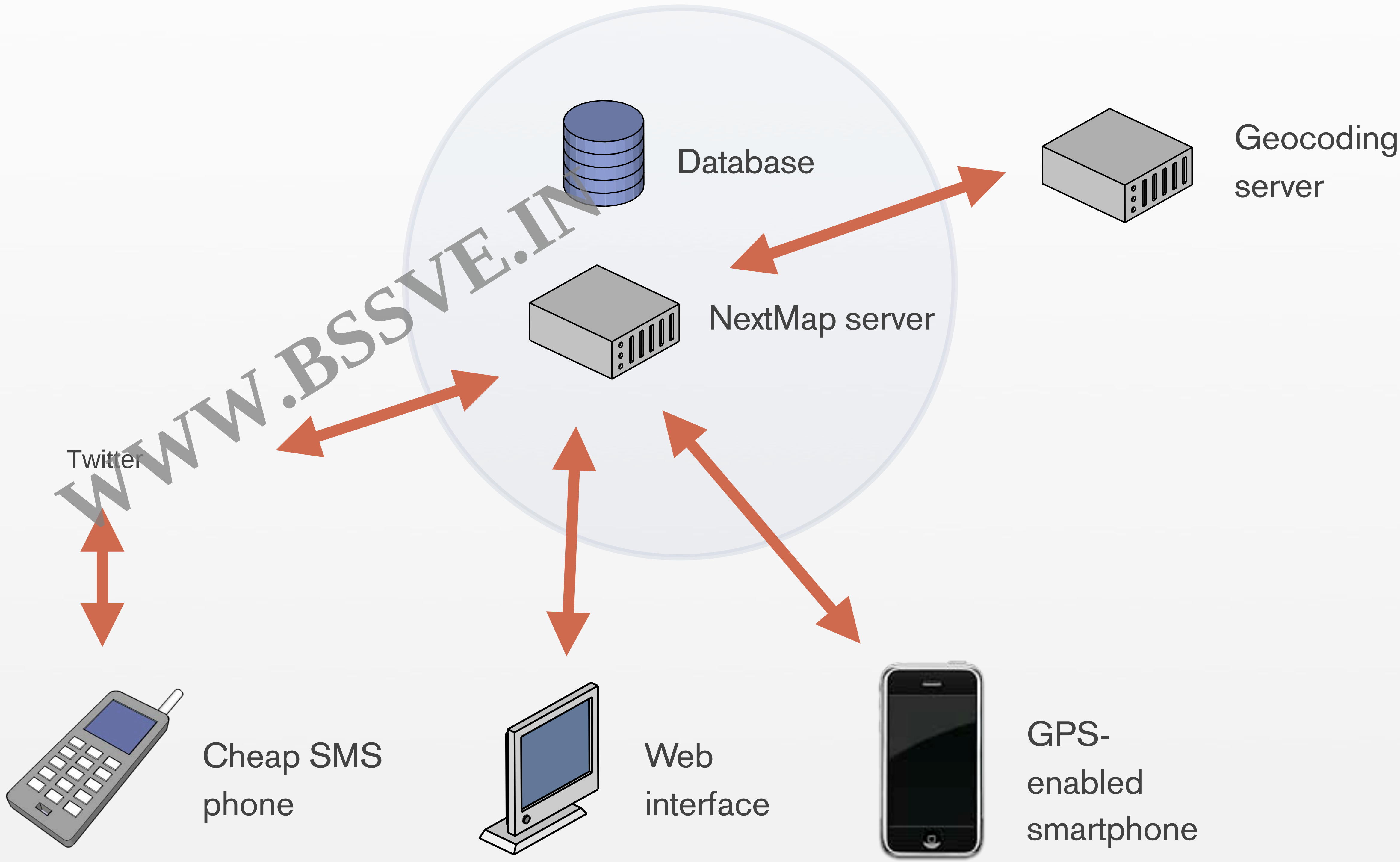
Too specific - i.e. only for law enforcement

Proprietary

Expensive hardware

One-way (Harvard's SMS emergency notification system)

System architecture



Modular SMS interface

Twitter

FrontlineSMS

Clickatell

Financial sustainability - CRS

Questionnaire

Equipment cost:

$50 per phone + service

$23,000 for pilot = 20 villages & 28,400 people

Service cost:

High data density per message

Platform:

Java 2 Mobile Edition

NextMap

Equipment cost:

Uses existing phones

New phones available for < $12 + service

Service cost:

Outgoing SMS paid for by Twitter

Platform:

Any phone with SMS

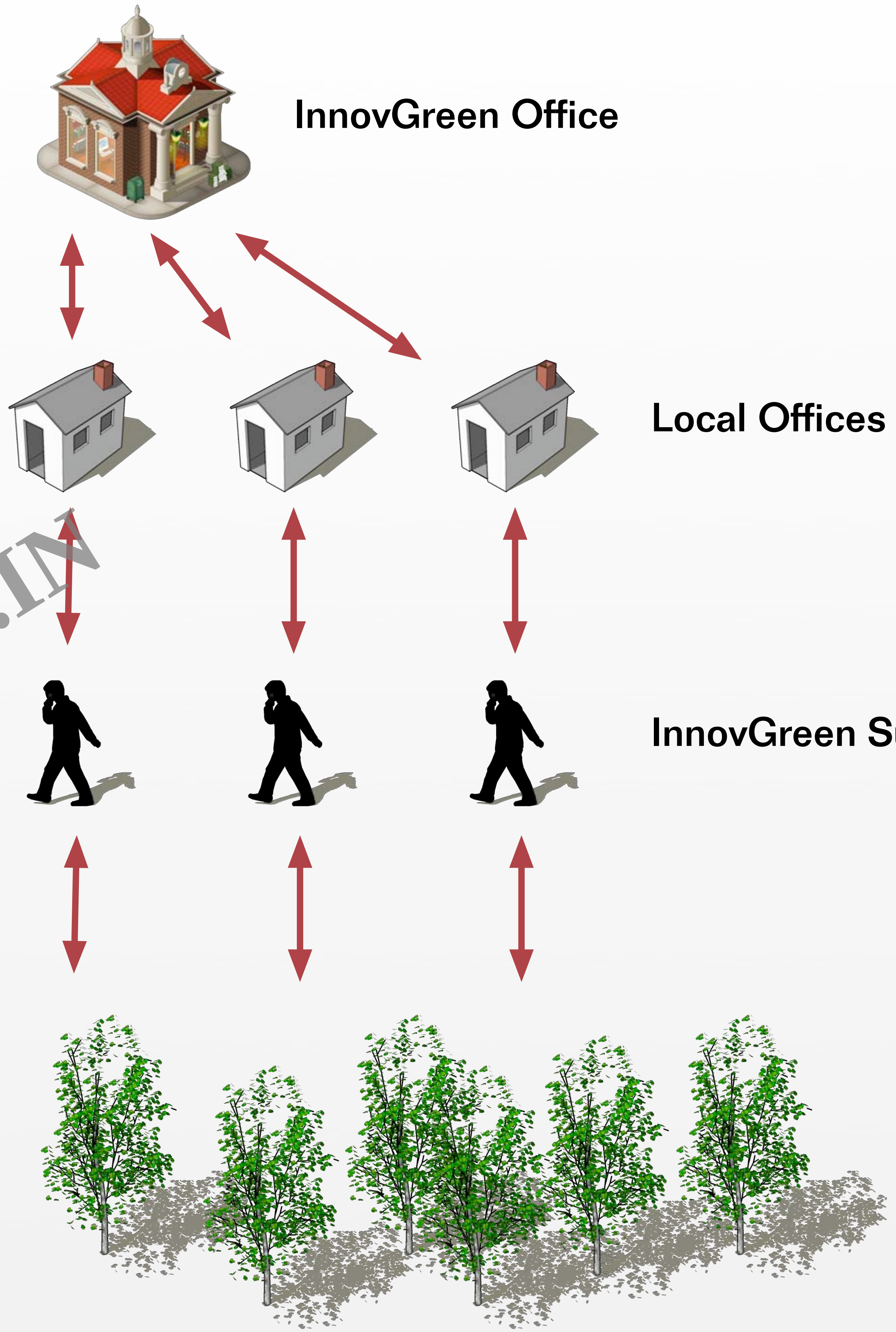
InnovGreen: Vietnam

Agent Orange deforestation

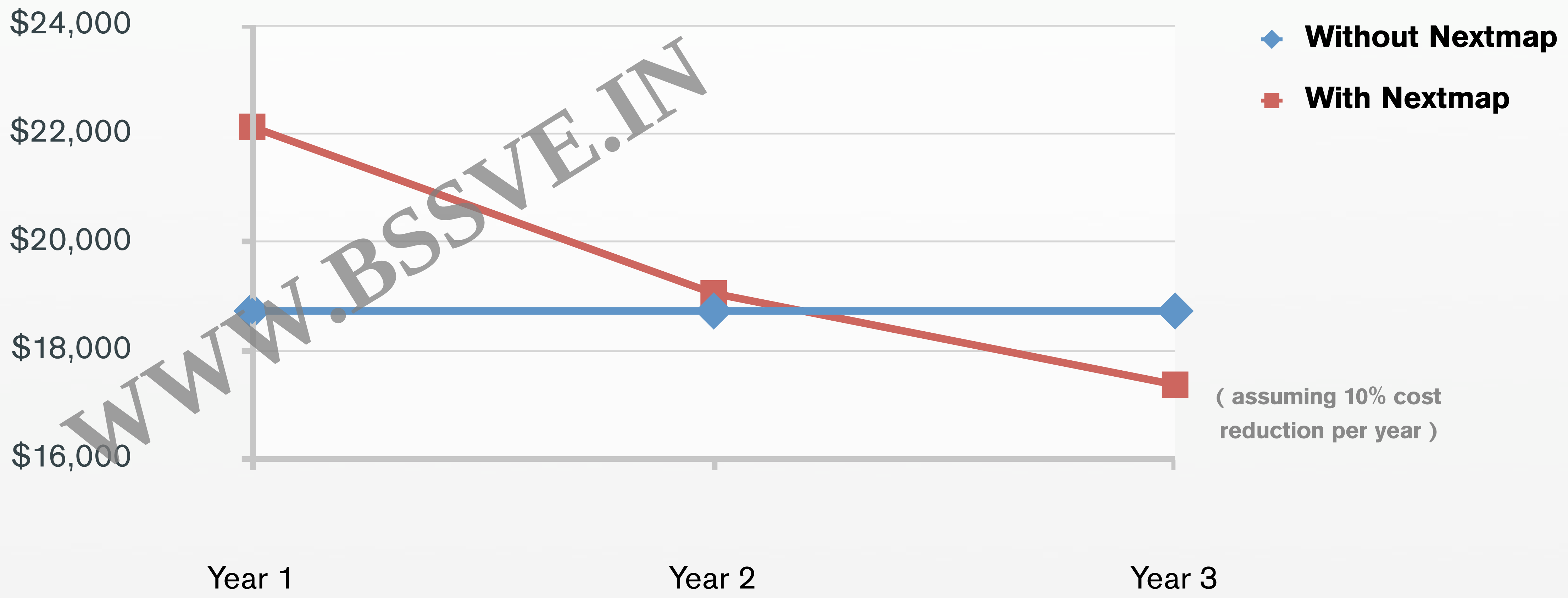
Map image removed due to copyright restrictions.

InnovGreen Need

No reliable way for farmers to send data - text, GPS location and images - from remote deforested areas back to main InnovGreen office.

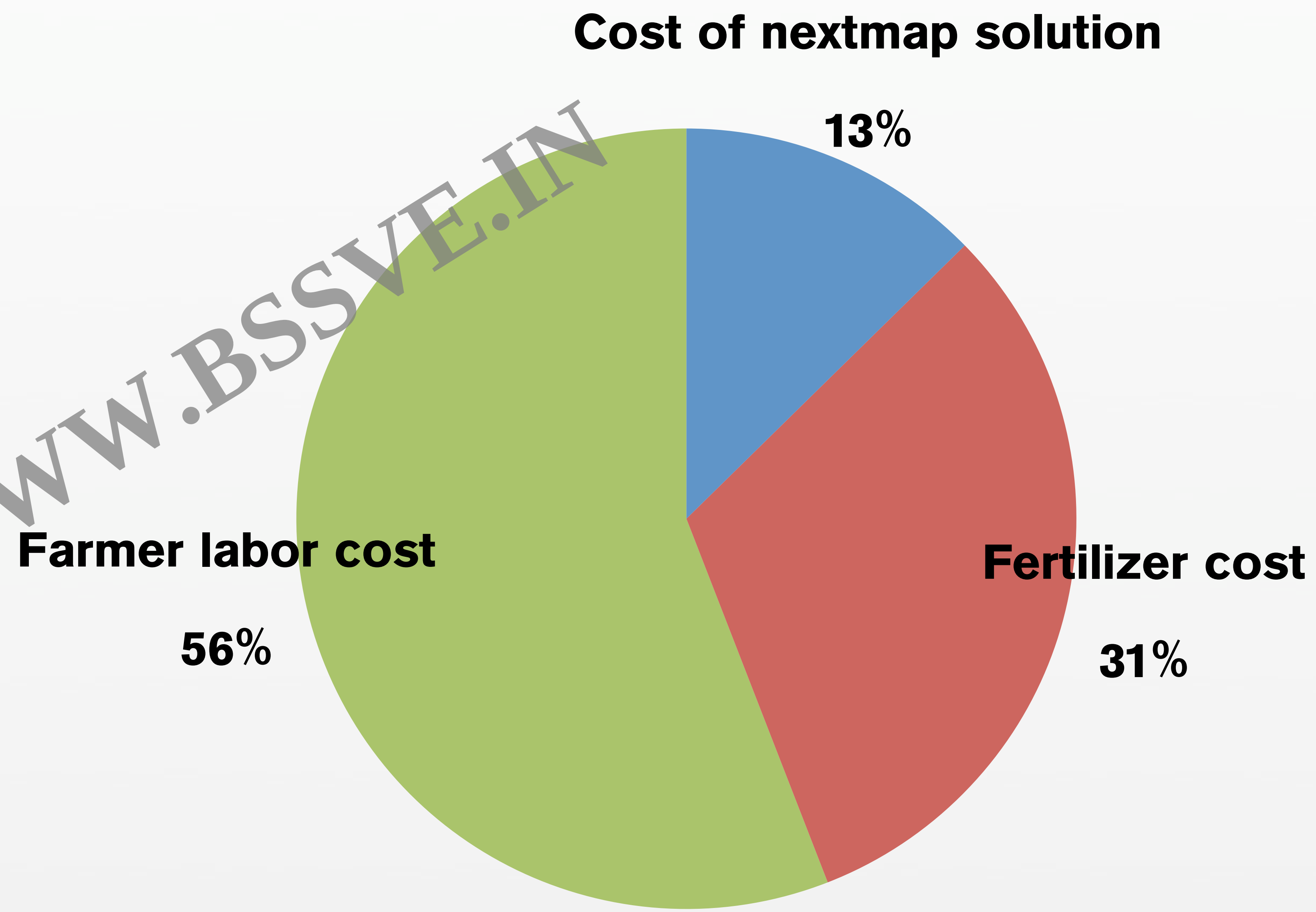


Financial sustainability - InnovGreen



Fertilizer and labor cost reduced to below current costs &without Nextmap) by year 3

Price breakdown



Key inputs

$400	HTC Touch Diamond
$10	mobile service per month
$2,400	IT admin per year
$4	farmer's pay per day
$0.25	NPK Fertilizer per kg

NextMap solution	Year 1	Year 2	Year 3
Mobile service	$1,000	$1,000	$1,000
Server	$2,400	$1,200	$1,200
Running cost of NextMap solution	**$3,400**	**$2,200**	**$2,200**

Performance metrics

NextMap Survey

Response time saved by giving CRS officers cell-based forms instead of paper forms.

NextMap SMS

Ability of users to respond in real time to geographic data on floods in June 2009.

InnovGreen

Reduced expenses from more efficient use of fertilizer; greater availability of data on reforestation.

Conclusion

NextMap makes low-cost geographic data analysis and communication available to billions of cell phone users worldwide.

http://nextmap.org

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nextlab

nextmap

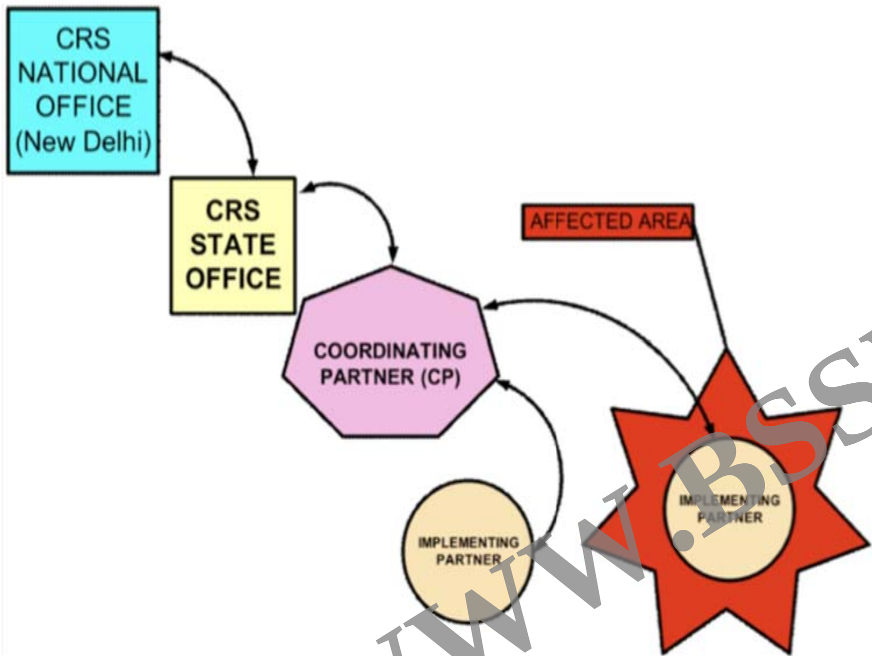
CRS + InnovGreen

Mobile Data Collection for Disaster Relief and Conservation

Need for rapid mobile communication & data collection platform

Currently paper-based communication takes 1 month for information to reach central office, and deploy response

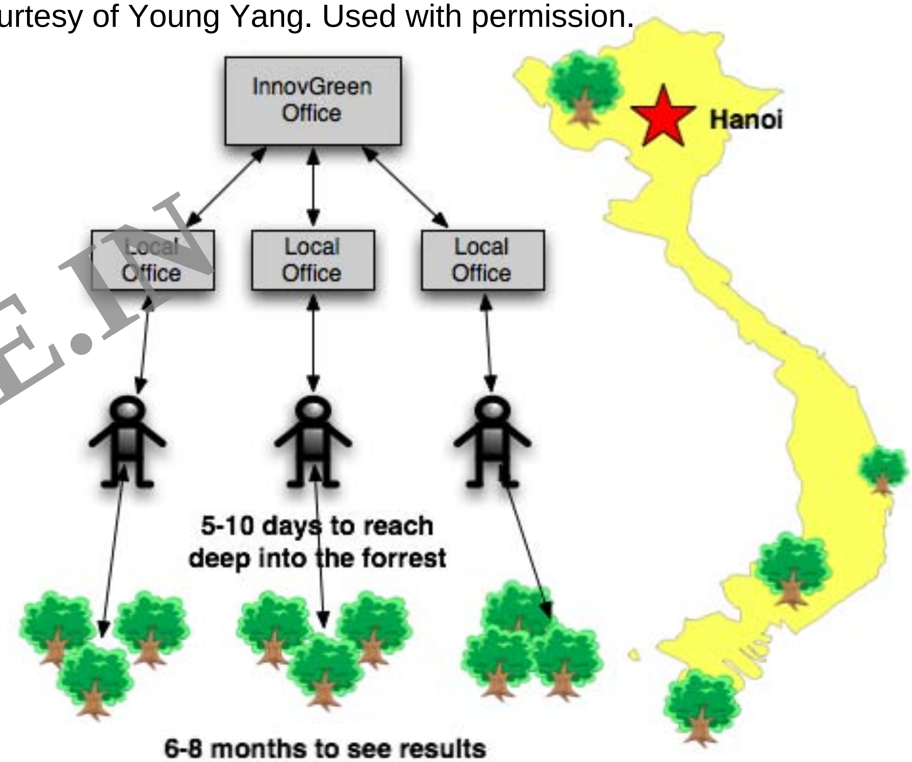
No reliable way for farmers to send data - text, GPS location and images - from remote deforested areas back to InnovGreen main office



Courtesy of Catholic Relief Services. Used with permission.

Disaster Management in India

Courtesy of Young Yang. Used with permission.



Restore Agent-Orange deforested land in Vietnam

Limitations of current systems for mobile disaster management

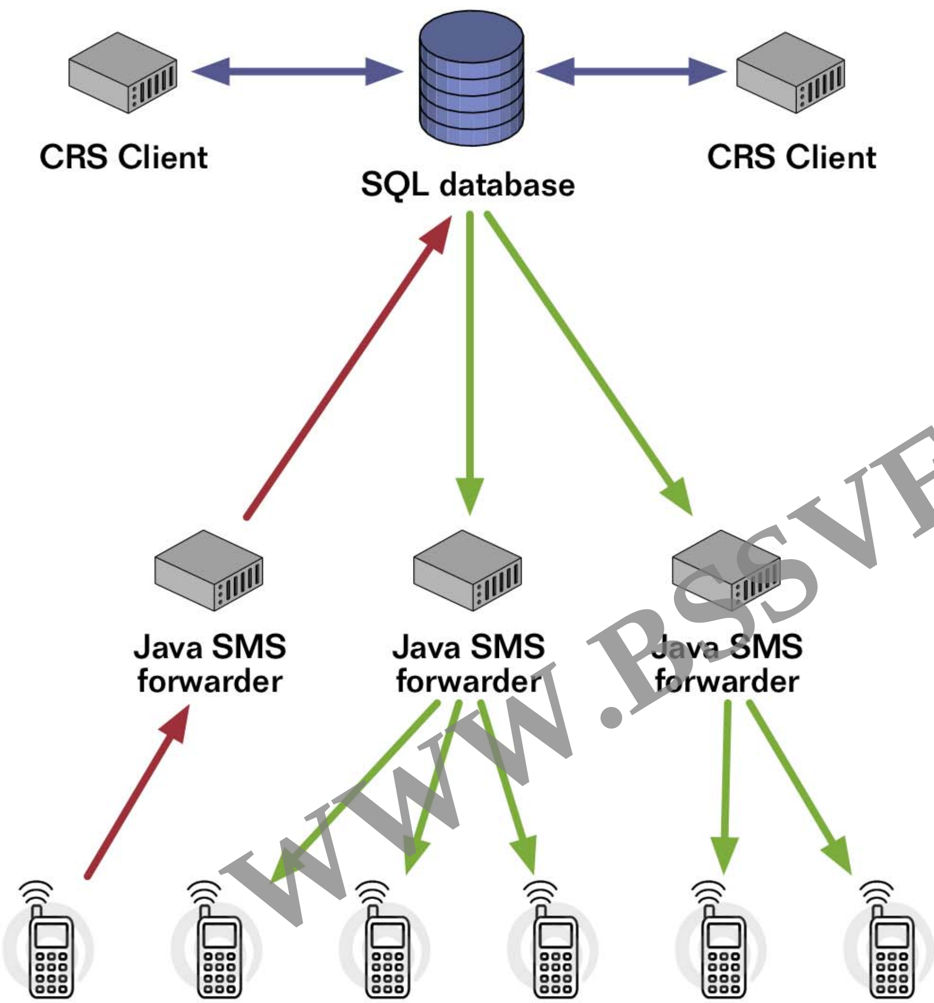
nextlab

What are the characteristics of current solutions?

- Designed for a very specific application, such as law enforcement, and are targeted for governments and large-scale organizations. (e.g. Intergraph's emergency management solutions)
- Proprietary
- Require "smart," sophisticated (and expensive) hardware
- One-way (e.g. Harvard's university-wide emergency notification system using SMS)

Solution: construct versatile toolkit for mobile data communication

NextLab 08
Distributed input for SMS to avoid bottlenecks



Key Toolkit Features

- Bi-Directional SMS
- Serialized Messages
- Trust-Based Networks

Key challenges

- Create versatile, platform agnostic toolkit for mobile data collection, processing, and dissemination
- Continue searching for existing mobile messaging ' technology that can be repurposed'
- Generic SMS web services API
- Support for additional data formats: GPS location, image'

Sample interfaces

“trust 777-777-7777”

“broadcast [message]”

“broadcast 1km north [message]”

"locate me [location string]"

"request update"

"request update 3km south"

Team Breakdown

- Operations - Anonymous MIT student
- Sustainability - Sreya Sengupta
- Systems Architecture - Jeffrey Warren
- Software Development - Oliver Wilder-Smith & Vijay Umapathy

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needs assessment milestone

Current Status

CRS disaster management

- Eager to fix system from last semester
- Have strict technology requirements (must use MSFT products & platform)

InnovGreen environment conservation

- Straightforward requirements
- More open to suggestions

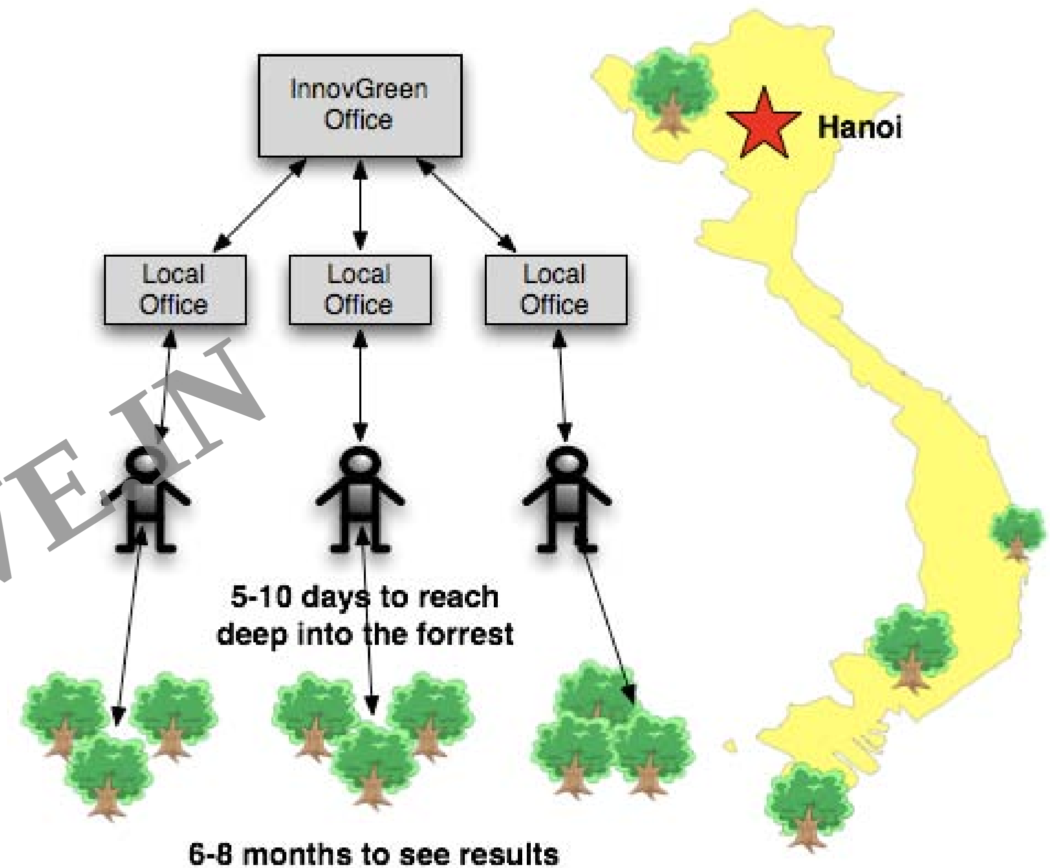
InnovGreen : Social Context

Project sponsored by InnovGreen

Social enterprise in Vietnam that promotes "sustainable forest management" by transforming bare hills and vast unproductive land into green, productive forest.

The role of Flow...

Flow is a social enterprise company in Taiwan that started InnovGreen



InnovGreen Key Requirements

Target user: Forestry department / InnovGreen inspector

Device: HTC Touch Diamond / Windows Mobile

- Collect information such as images (tree height, growth) and GPS location with a mobile phone
- Be able to upload the data from the phone to a central server
- Be able to view the data on a map (Google Earth)

Questions for InnovGreen

- **Optimizing existing system**

- How is the current process in inspecting fertilization/growth in a remote area?

- **Financial sustainability**

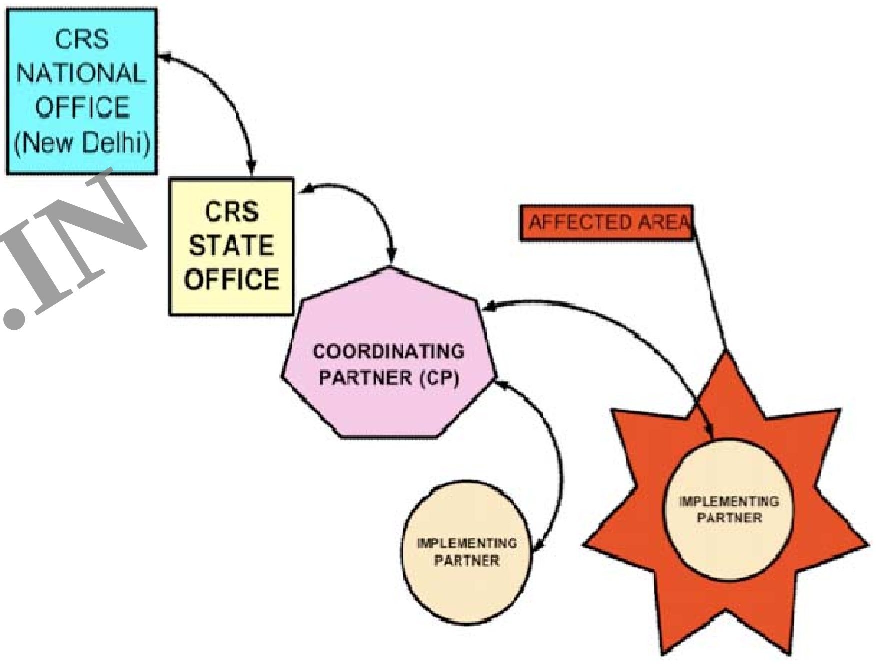
- What are the sources of financing for this project?
- IT costs: cost of cell phones devices, service, hosting service, maintenance, training
- Hiring costs: cost of contracting farmers

- **Operational sustainability**

- partnership structure with forestry management department
- availability of system maintenance personnel

CRS - Social Context

- **CRS is an international humanitarian agency of the U.S. Catholic community.**
- **They provide assistance to people in need without regard to race, religion or nationality.**
- **Major flooding in India annually**
- **Infratructure damage and people displacement**



Courtesy of Catholic Relief Services. Used with permission.

CRS Requirements

- Need for quick dissemination of information
- Need for an easy-to-use solution available for CRS partner organizations and potentially for villagers themselves.
- Must fit in with CRS's current systems to ensure sustainability, and ease of use.
- Must work on both high-end and low-end cellphones
- Must allow for limited proficiency in written English.

Questions for CRS

Optimizing the Existing System:
- What features of the current phone-based system are appealing to the field user?
- What are the key features of the current system for disaster relief coordinators at the central office?

Financial Sustainability:
- What are CRS's financial resources, and how much can they afford to sustain the network?
- What are other possible sources of revenue for the network?

Operational Sustainability:
- What caused the existing system to crash, and how could this be prevented in the future?
- How many simultaneous users will need to be supported?
- At what level does CRS want to be involved in maintaining the system?

Major Differences

Phone platform: Baseline phone for CRS is low on features and possibly heterogeneous, InnovGreen using standardized smartphone (HTC Diamond)

Scale:

- InnovGreen is about control of information - or rather, validating location and possibly photographic information.
- CRS is about reducing latency in a communications system, and in a broader sense, allowing people to manage group-based trust/communication.

Common Denominators

- Mapping information
- Organization of large amounts of location-specific data
- Network is internal, so finding revenue sources outside the organization is difficult
- Dealing with an inconsistent cellular network

And ideally:

- User-modifiable code. (Warana rebuilt their original software themselves, with a better understanding of the problem)

Next Steps

- Get all questions answered
- Get a working version of the old CRS application

- User Interface design

MIT OpenCourseWare
http://ocw.mit.edu

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System Architecture Milestone

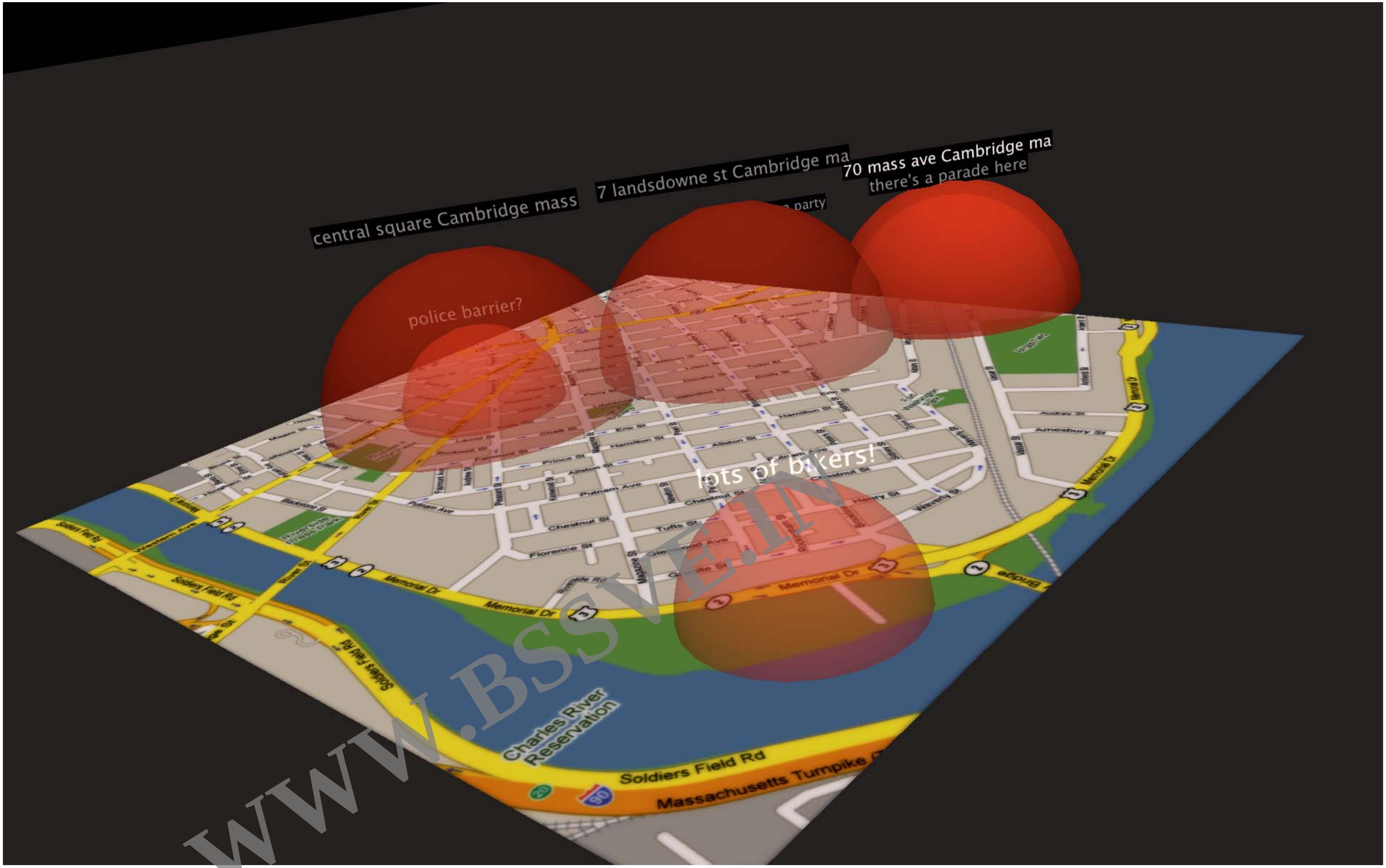
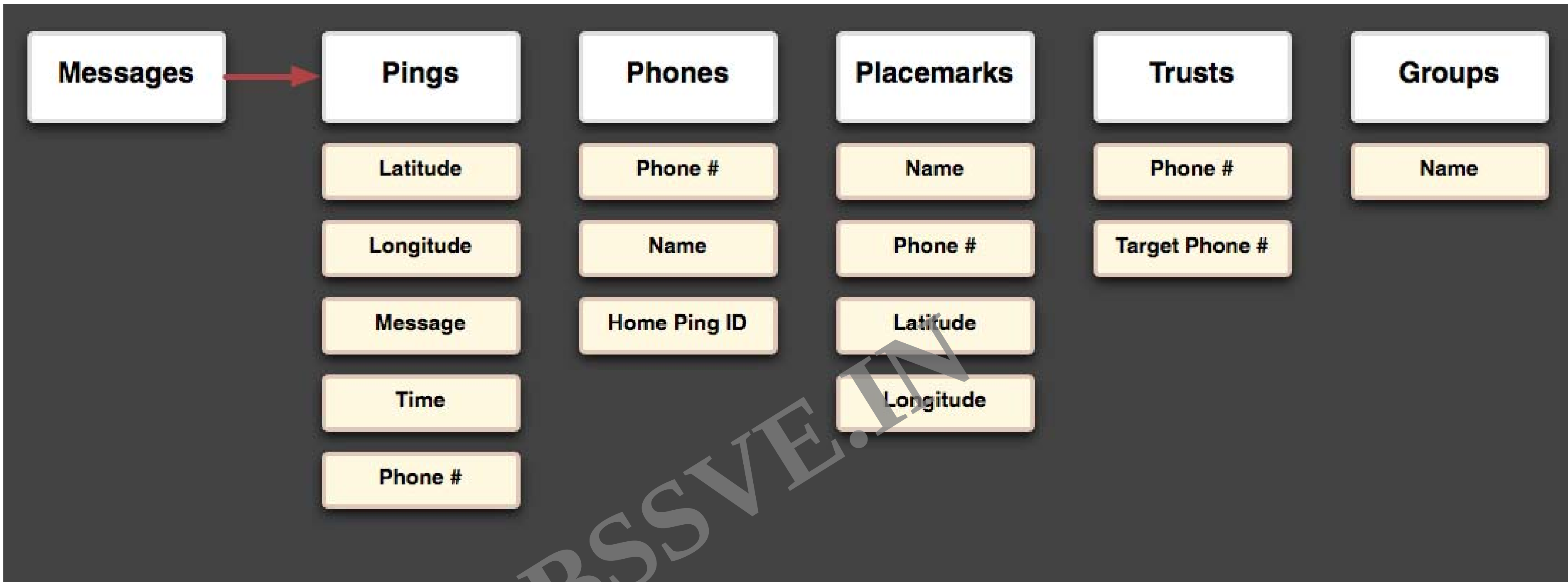

central square Cambridge mass
7 landsdowne st Cambridge ma
70 mass ave Cambridge ma
there's a parade here
police barrier?
lots of bikers!
Charles River Reservation
Soldiers Field Rd
Massachusetts Turnpike
Memorial Dr

Image by MIT OpenCourseWare, substituted for a Google Maps image.


Messages
Pings
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Groups
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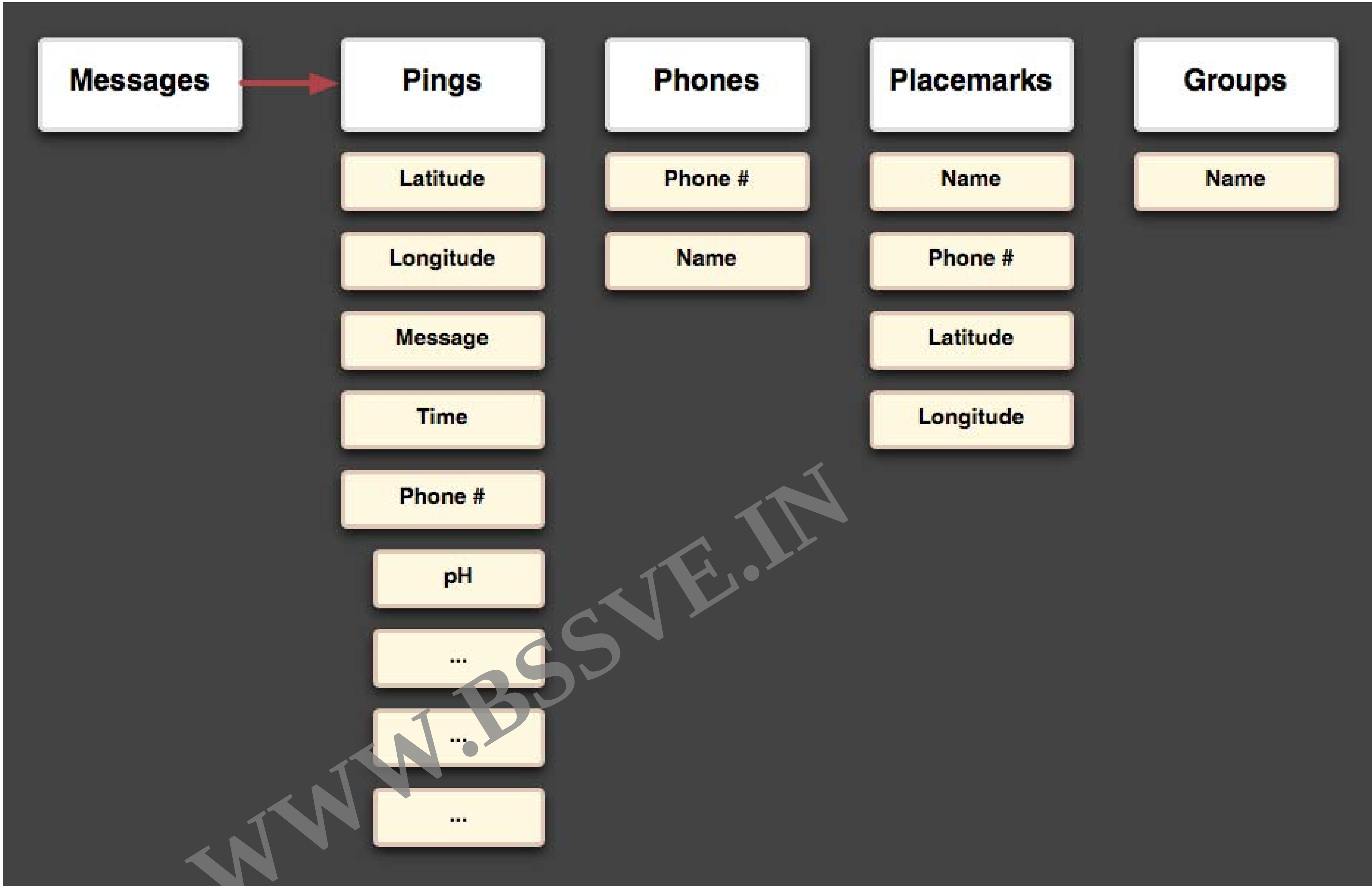
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Longitude
Name

CRS Questionnaire

Categories of Questions Required
(50 Questions Total)

- General Information
- Affected Area (Geographic Information)
- Demographic Damage
- Health / Infrastructure / Shelter
- Water / Food / Sanitation
- Response from Others / Protection

Prototype Mobile UIs: CRS

Multiple-Choice Input

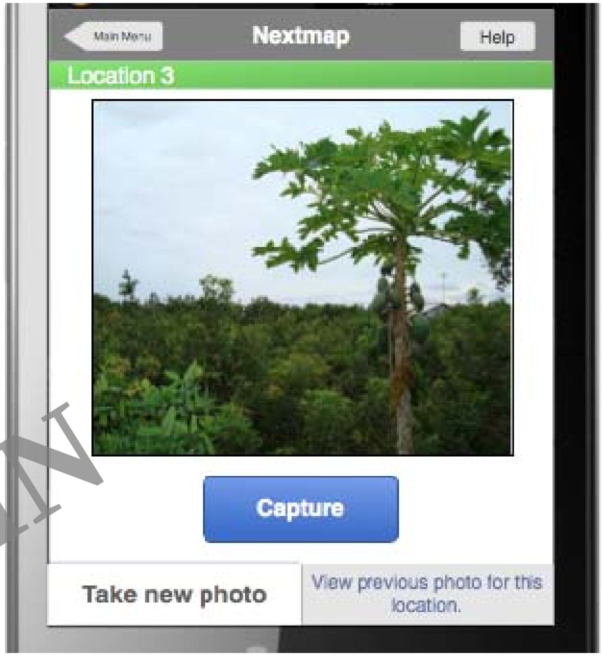
Yes/No Answers

Prototype Mobile UIs: CRS

Our interface will include input vallidation, to ensure accuracy and ease of use.

Prototype Mobile UIs: Innovgreen

Overview of Sites



Collecting data for a site

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Sustainability Milestone

Sreya Sengupta, Vijay Umapathy, Jeffrey Warren,
Oliver Wilder-Smith, and anonymous MIT student

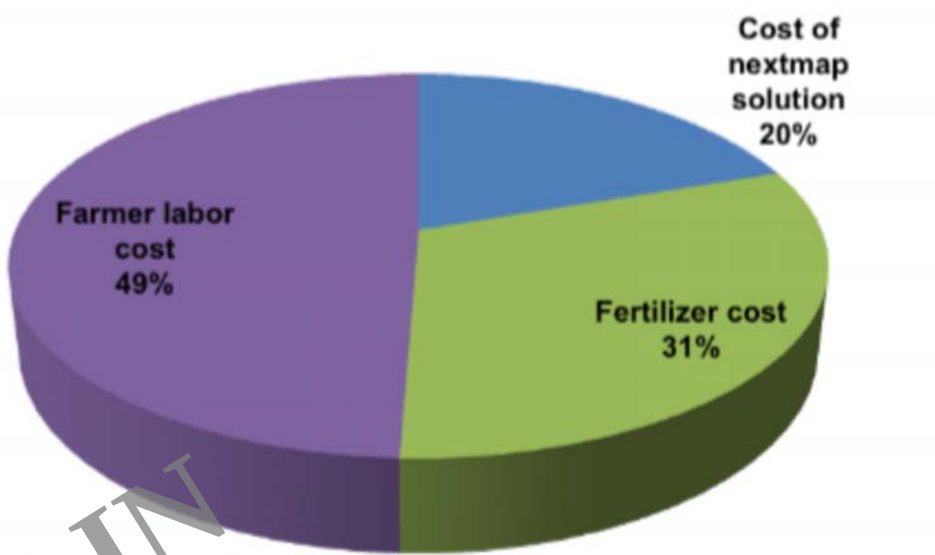
Image removed due to copyright restrictions.
Map: "Worldwide Growth in Fertilizer Use."
http://www.nytimes.com/imagepages/2008/04/30/business/20080430_FERTILIZER_GRAPHIC.html

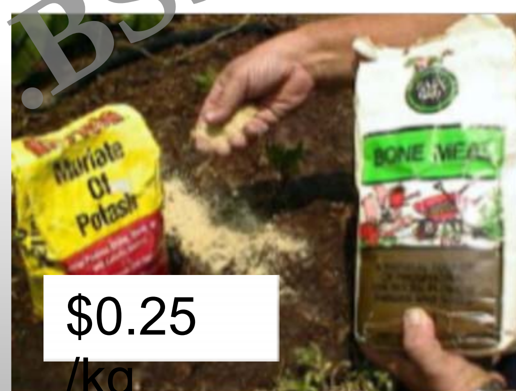
Local fertilizer prices have doubled and even tripled over the past year (Viet Nam Fertilizer Association)

Source: New York Times April 30, 2008

InnovGreen: Nextmap = 20% of total cost

Cell phone cost	$4,000 (one time cost)	
Mobile service cost	$1,200	
Server cost	$1,200	
IT administrator	$2,400	
Cost of nextmap solution	$4,800	20%
Fertilizer cost	$7,500.00	31%
Farmer labor cost	$12,000.00	49%
Total	$24,300.00	100%





Costs & Benefits

- Cost savings…
  - Avoid farmers reselling or dumping fertilizer on the road
  - Optimize fertilizer formula by gathering and tracking pH data
- Better information organization…
  - Communicate progress across teams easily
  - Centralized view of data - eliminate paper, file cabinets

Operational sustainability

- Phased roll-out – start with 5 teams in Quang Ninh and roll-out to a total of 10 teams
- Training: inspectors, technical staff, administrator

Natural Disaster Hotspots

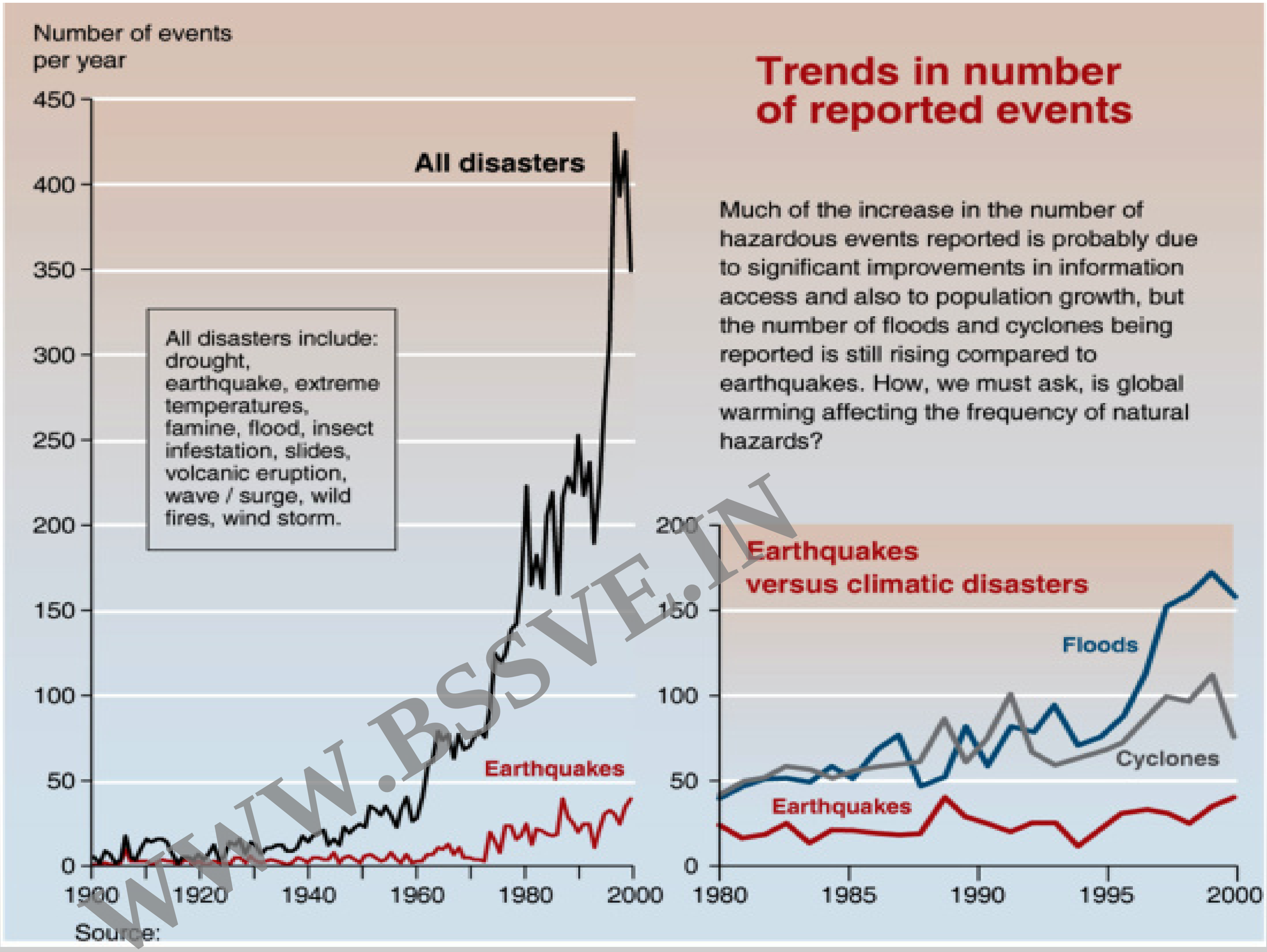
Image removed due to copyright restrictions.

World map showing regions with high proportional economic risk due to vulnerability to two more more hazards.

World Bank. (Dilley, Maxx; Robert S. Chen, Uwe Deichmann, Arthur L. Lerner-Lam, and Margaret Arnold, with Jonathan Agwe, Piet Buys, Oddvar Kjekstad, Bradfield Lyon, and Gregory Yetman). 2005. Natural Disaster Hotspots: A Global Risk Analysis. Washington, D.C.: World Bank.

- Significant improvements in information access have increased the number of hazardous events reported.
- The number of floods and cyclones being reported is increasing.

Recent Trends



Courtesy of UNEP/GRID-Arendal. Source: "Trends in Natural Disasters," UNEP/GRID-Arendal Maps and Graphics Library, http://maps.grida.no/go/graphic/trends-in-natural-disasters (Accessed 22 June 2009).

Centre for Research on the Epidemiology of Disasters (CRED)

CRS Costs

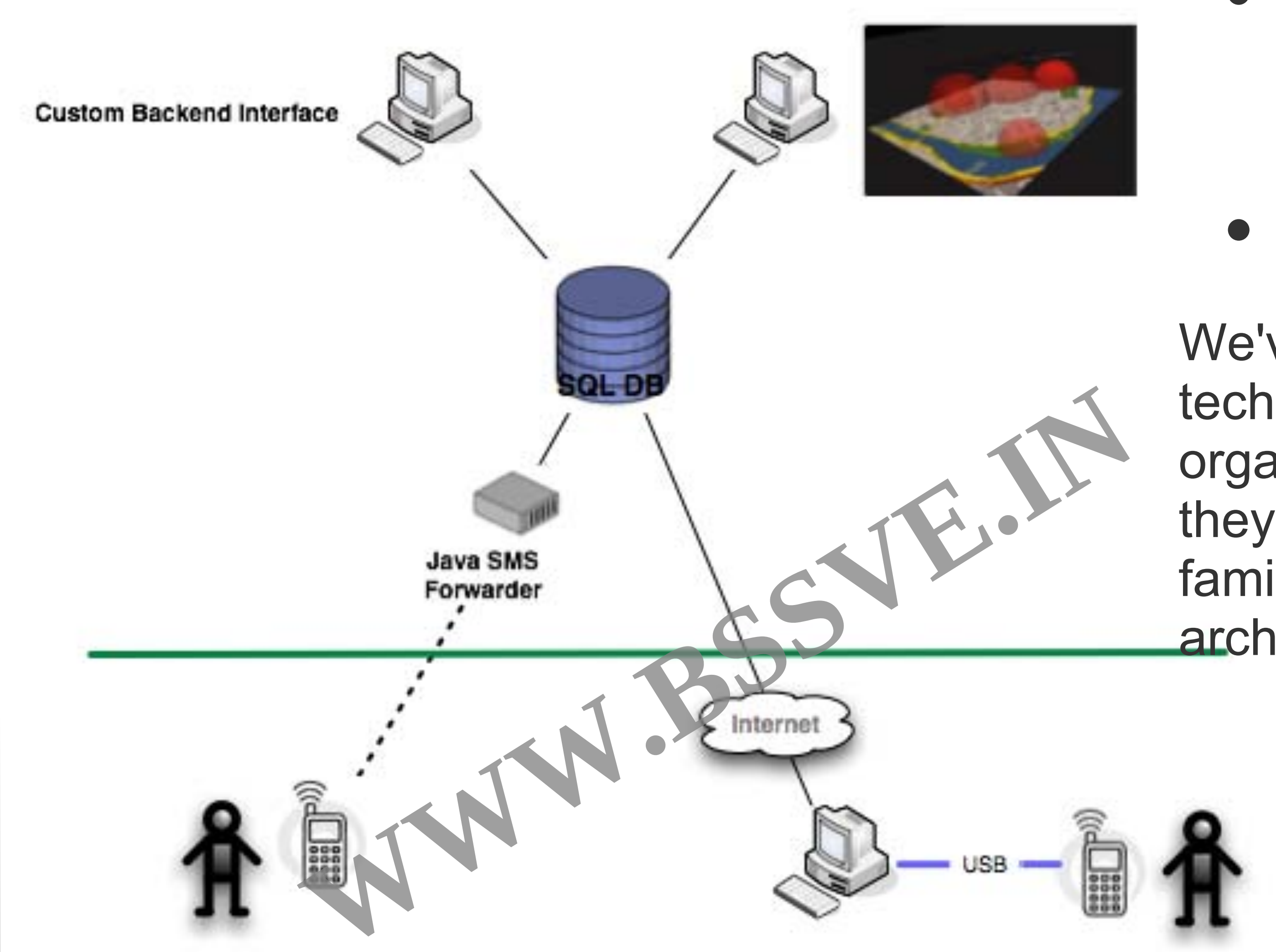
Courtesy of PlaneMad. Used with permission.

- The phones cost CRS $100 with a monthly rental of $10.
- The approximate salary of relief workers are $250-$350 per month, at the village level.
- CRS has internally budgeted for the pilot and technical maintenance of the system.

Operational Sustainability

- CRS wants to be comfortable with this technology before exploring larger-scale options.
- Relief workers are 100% comfortable using mobile phones and SMS.
- CRS IT department will be responsible for technically maintaining the system.
- Hindi is the preferred language of the system.

Technological sustainability



Flexible, Modular Design:

- Two front-end interfaces- internet upload and mobile SMS
- Customizable backend interface

We've worked closely with technical staff in both partner organizations to ensure that they are comfortable and familiar with the system architecture.

Nextmap's future

- InnovGreen: "Plant-a-tree" program
  - Any one can fund planting and fertilization of a tree and see it grow on Nextmap
- CRS: information sharing between relief worker in the same location
- CRS: information sharing with other relief organizations