computing for the underserved

yaw anokwa

learning math and science in ghana

discovering computers


making mistakes and
making money
Jason dV

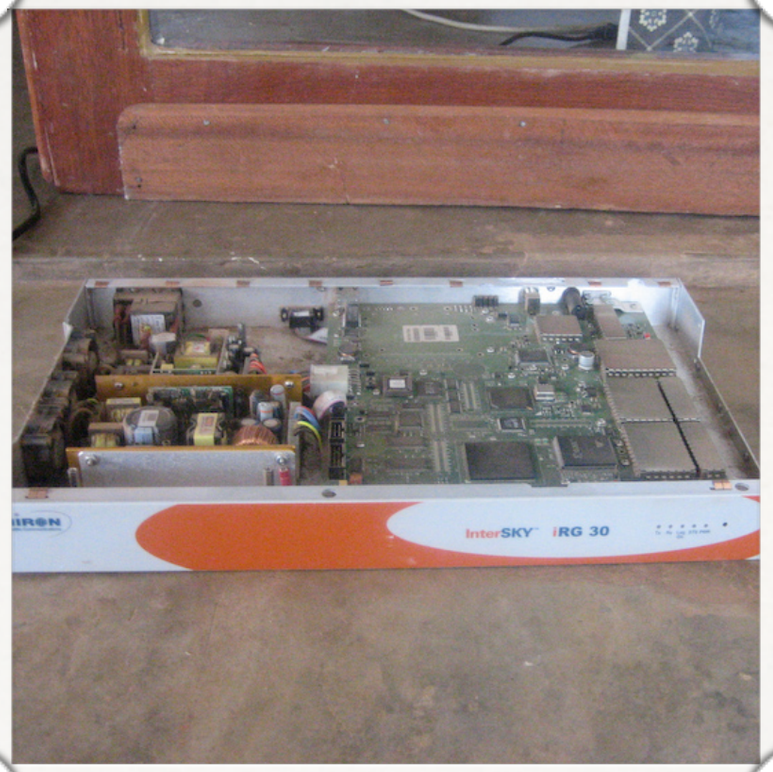
moving print online

computing for defense

inventing gadgets

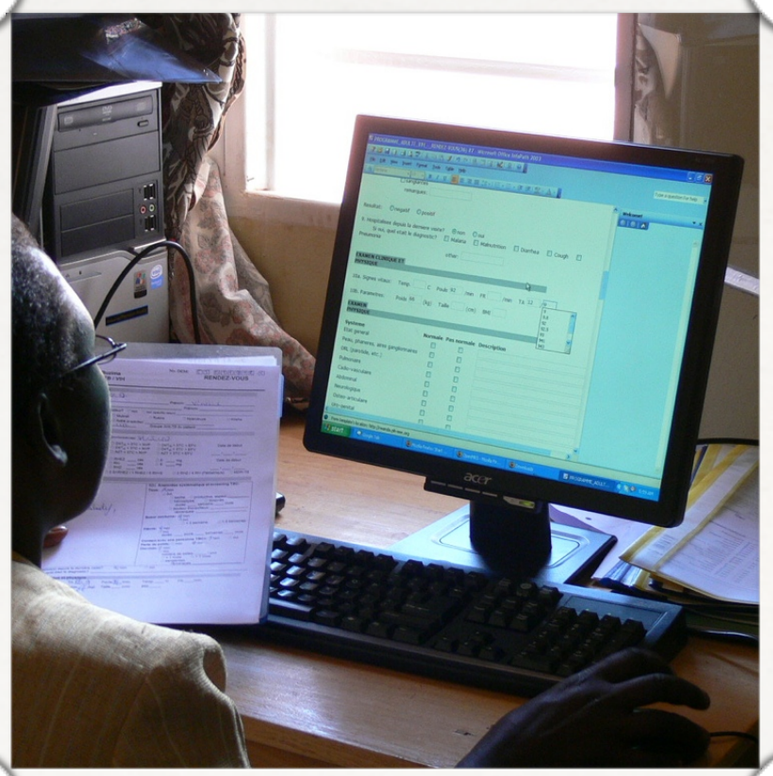
Six months in rural Rwanda

Deploying infrastructure



Training staff

Observing clinical care



Managing data team

Paper provides both the information capture and retrieval

Paper-based systems are hard to search or transport

Paul Persil Patient

Back Print

Gender **Male**
Age **44 years** (~ Jun 01, 1934)
Last Visit **1 week ago** (Aug 14, 2008)
Doug Doctor, Rwinkwavu Hospital

TRACnet ID: 12345
Carte d'Identité: 1234567

IMB ID **12345678-A**

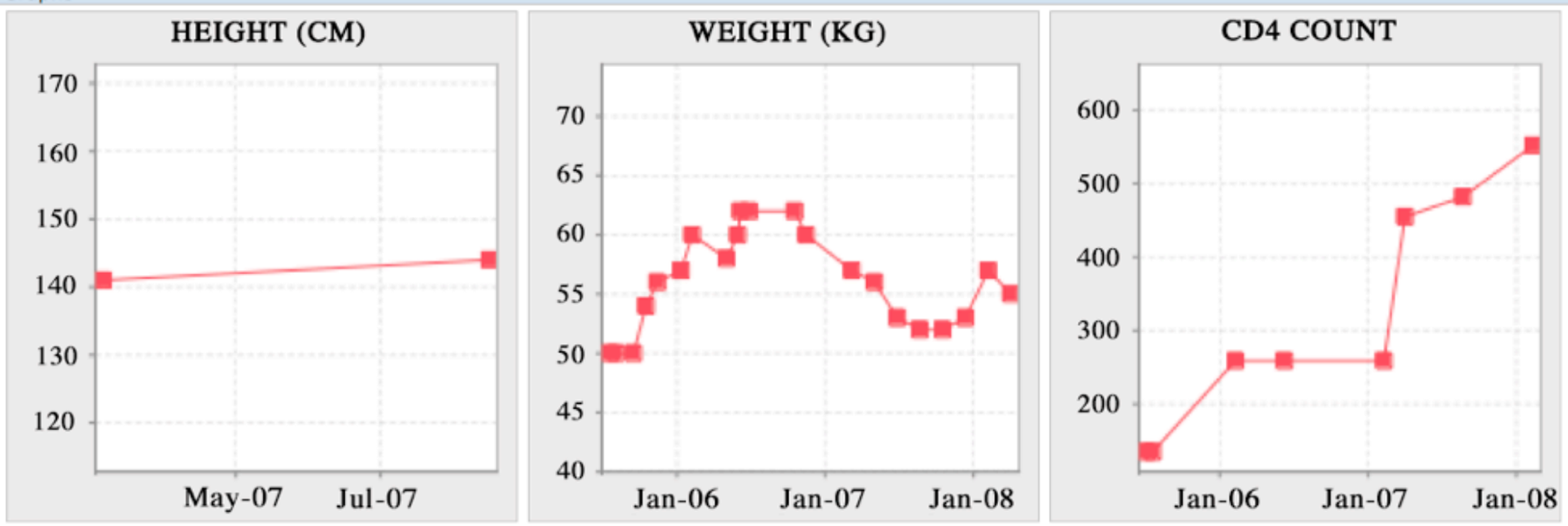
Alerts
NO XRAY RESULT IN THE LAST 6 MONTHS
NO CXR RESULT

Notes
No known allergies

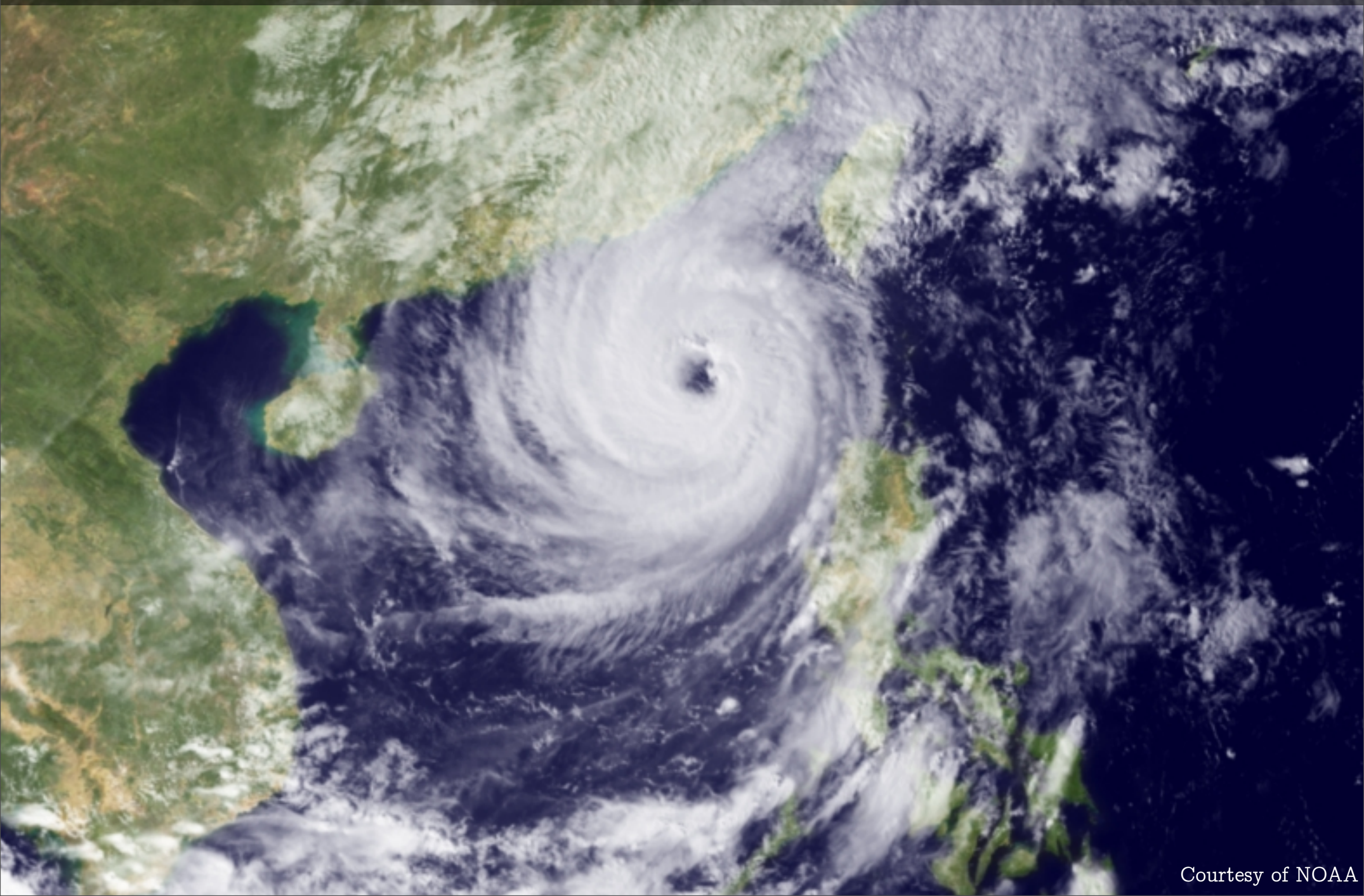
Drug Order	Dose	Frequency	Start Date	Stop Date	Notes
AZT+3TC	1.0 tab(s)	2/d x 7 d/w	Sep 13, 2007		
D4T	150 mg	1/d x 7 d/w	Aug 02, 2007		
Triomune-40 (stopped)	1.0 tab(s)	2/d x 7 d/w	Sep 01, 2007	Sep 13, 2007	Unexplained facial rash
EFV 600 (stopped)	1.0 mg	1/d x 7 d/w	Aug 02, 2007	Sep 13, 2007	

Lab Test	Result	Date	Notes
CD4	**512**	Aug 15, 2008	Ordered by Dr. Doctor
CD4	**259**	Aug 01, 2008	
Viral load	**515**	Jul 28, 2008	Second test for verification of status
Viral load	200	Jul 27, 2008	Ordered by Dr. Green

Graphs



Data collection could provide much richer information



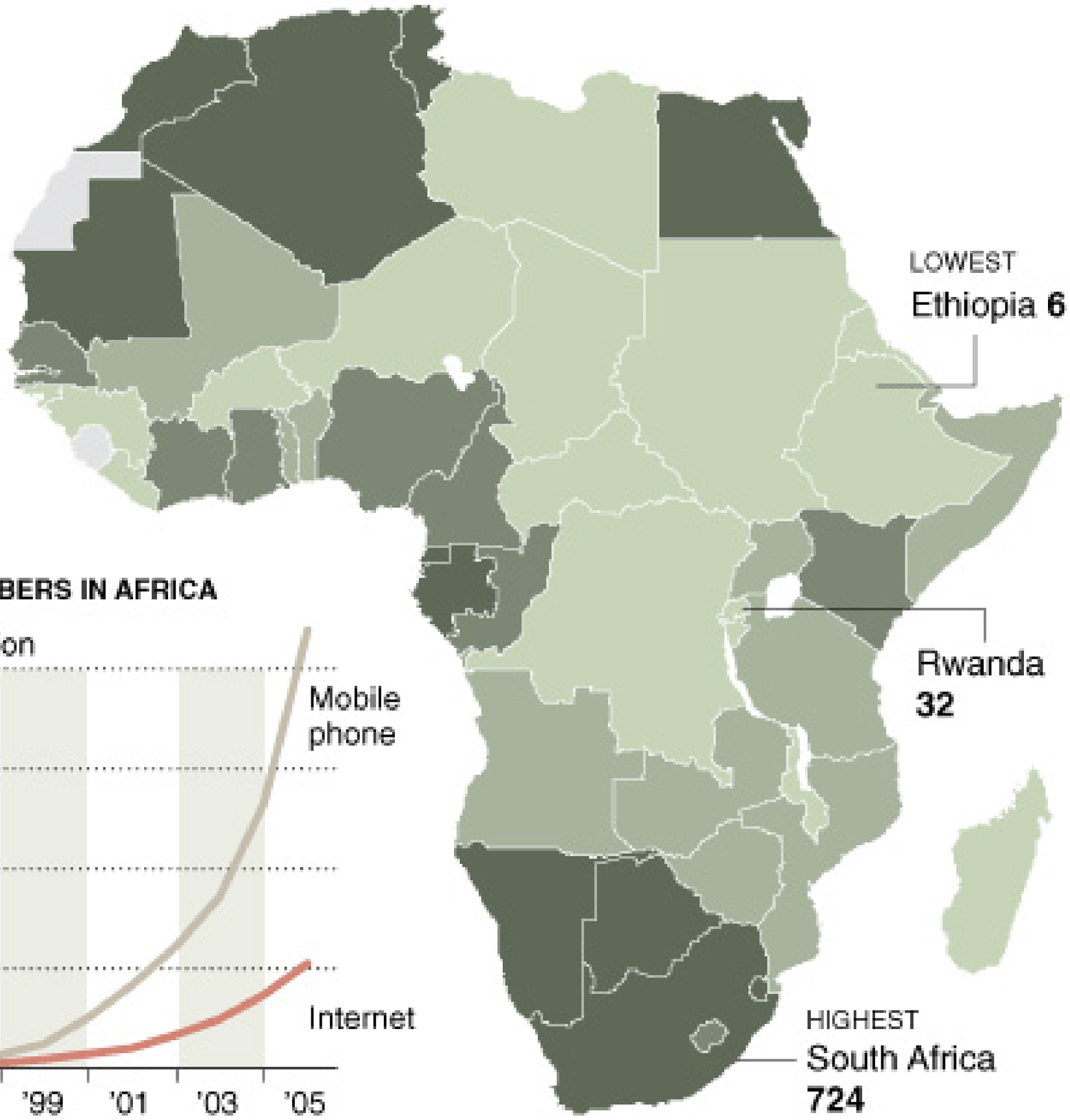
Courtesy of NOAA

Paper-based practice in low-income regions limits the scale, complexity and impact of interventions.

Mobile phone subscribers per 1,000 people, 2005

6 — 50 — 100 — 150 — 724

Data not available



SUBCRIBERS IN AFRICA

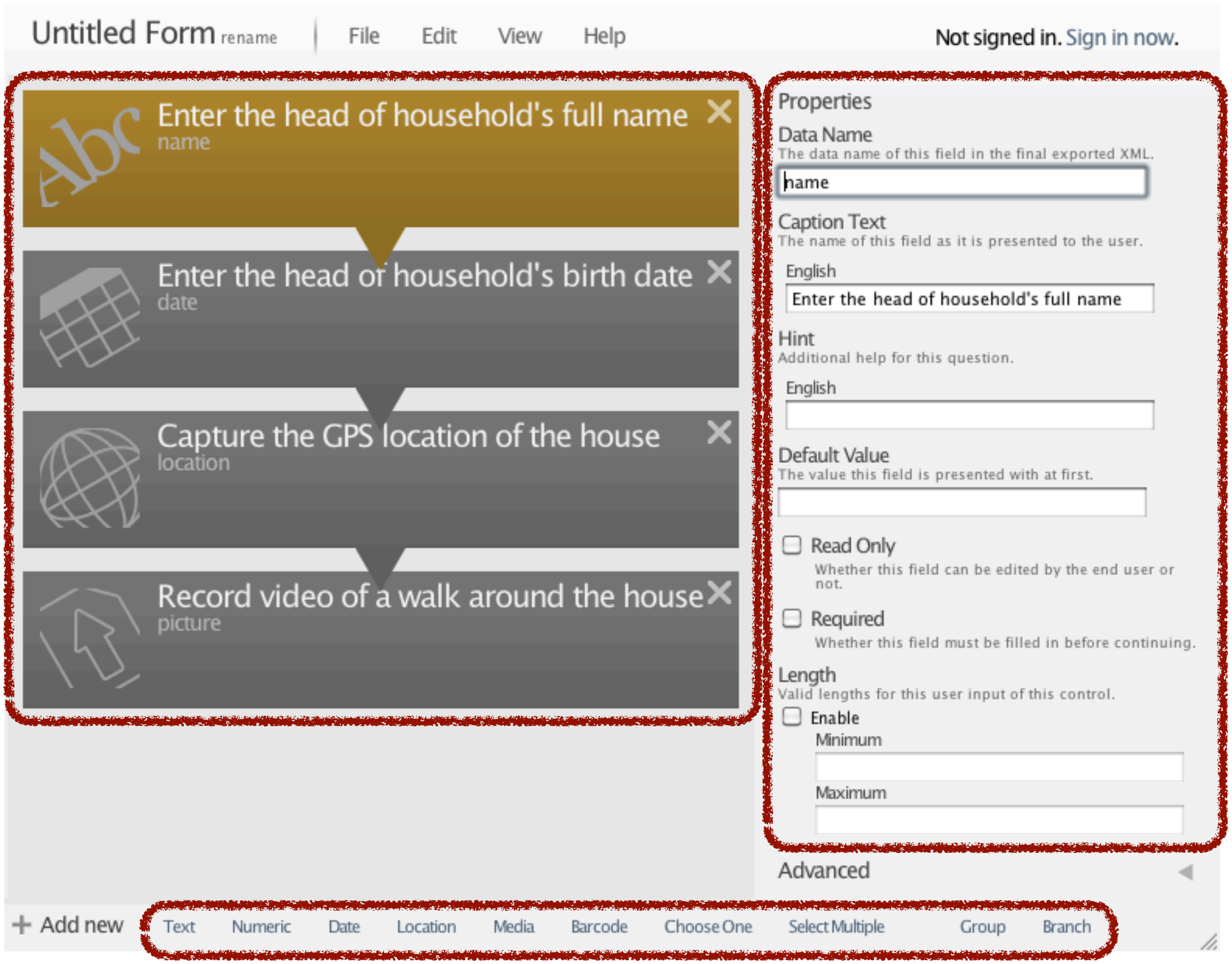
Open Data Kit

Building Information Services for Low Income Regions

Yaw Anokwa, Carl Hartung, Waylon Brunette,
Adam Lerer, Clint Tseng, Gaetano Borriello

http://opendatakit.org

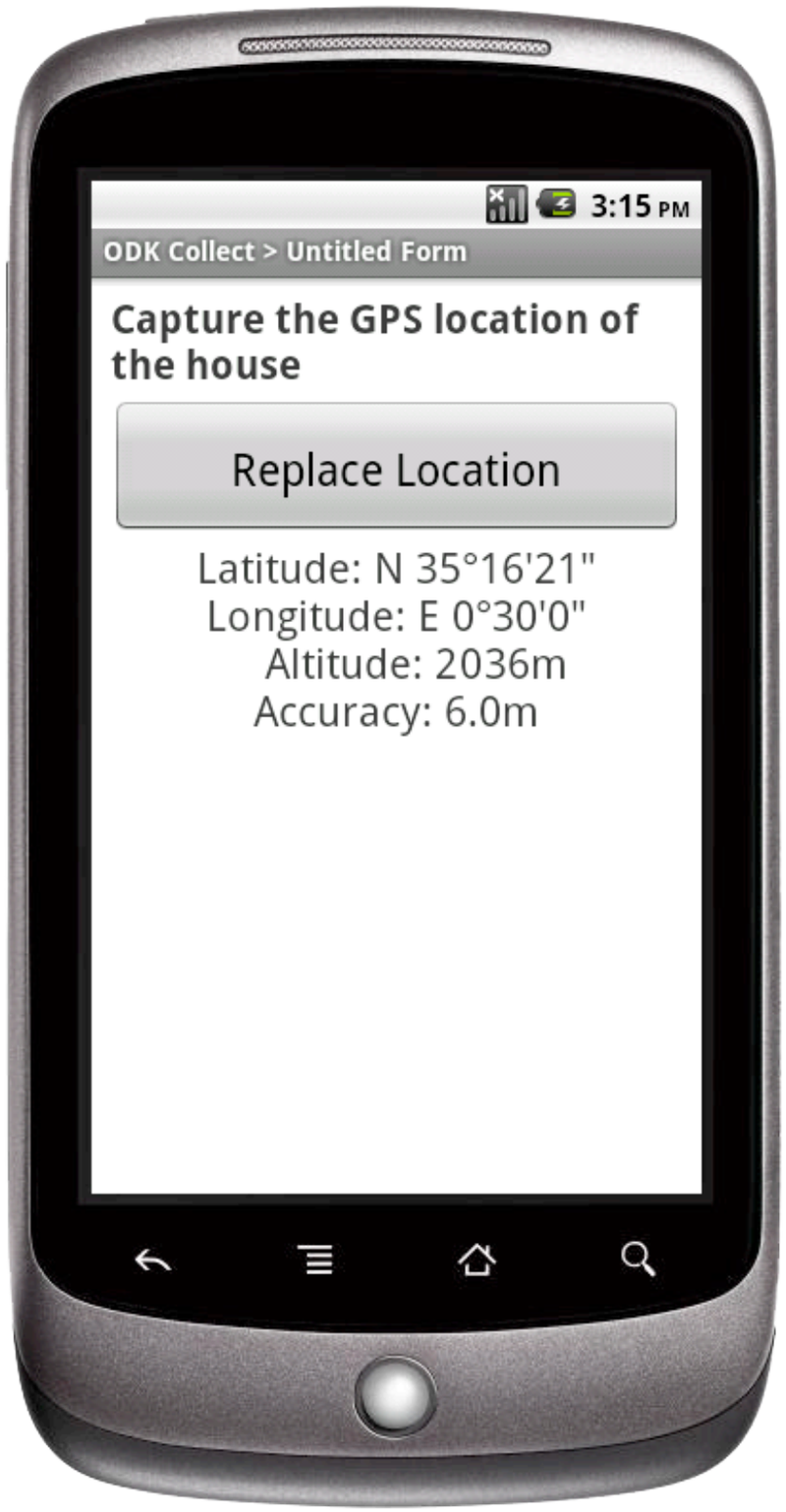
ODK Build: Drag and drop prompts for form creation



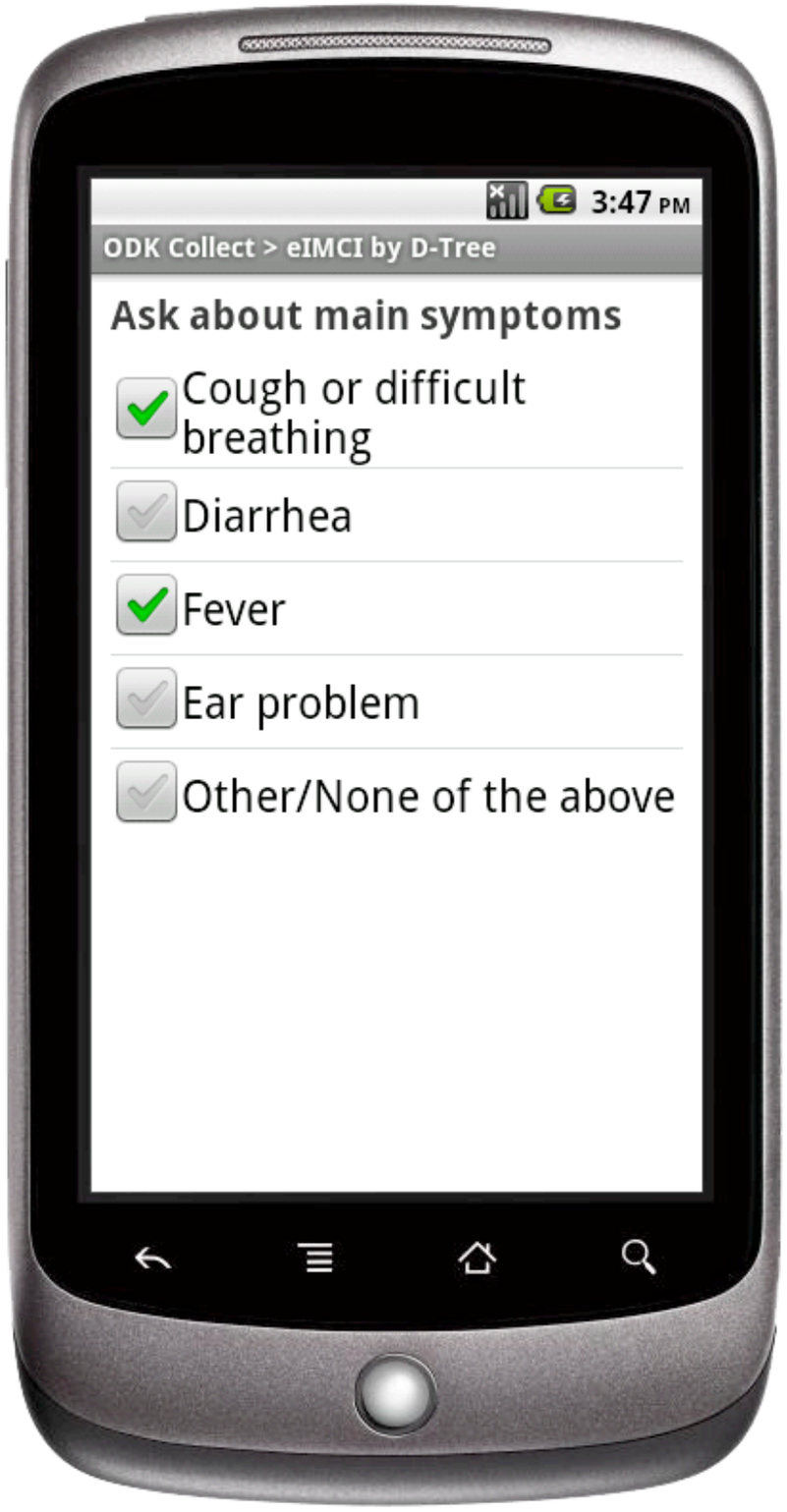
XForms: Describes the form logic and data schema

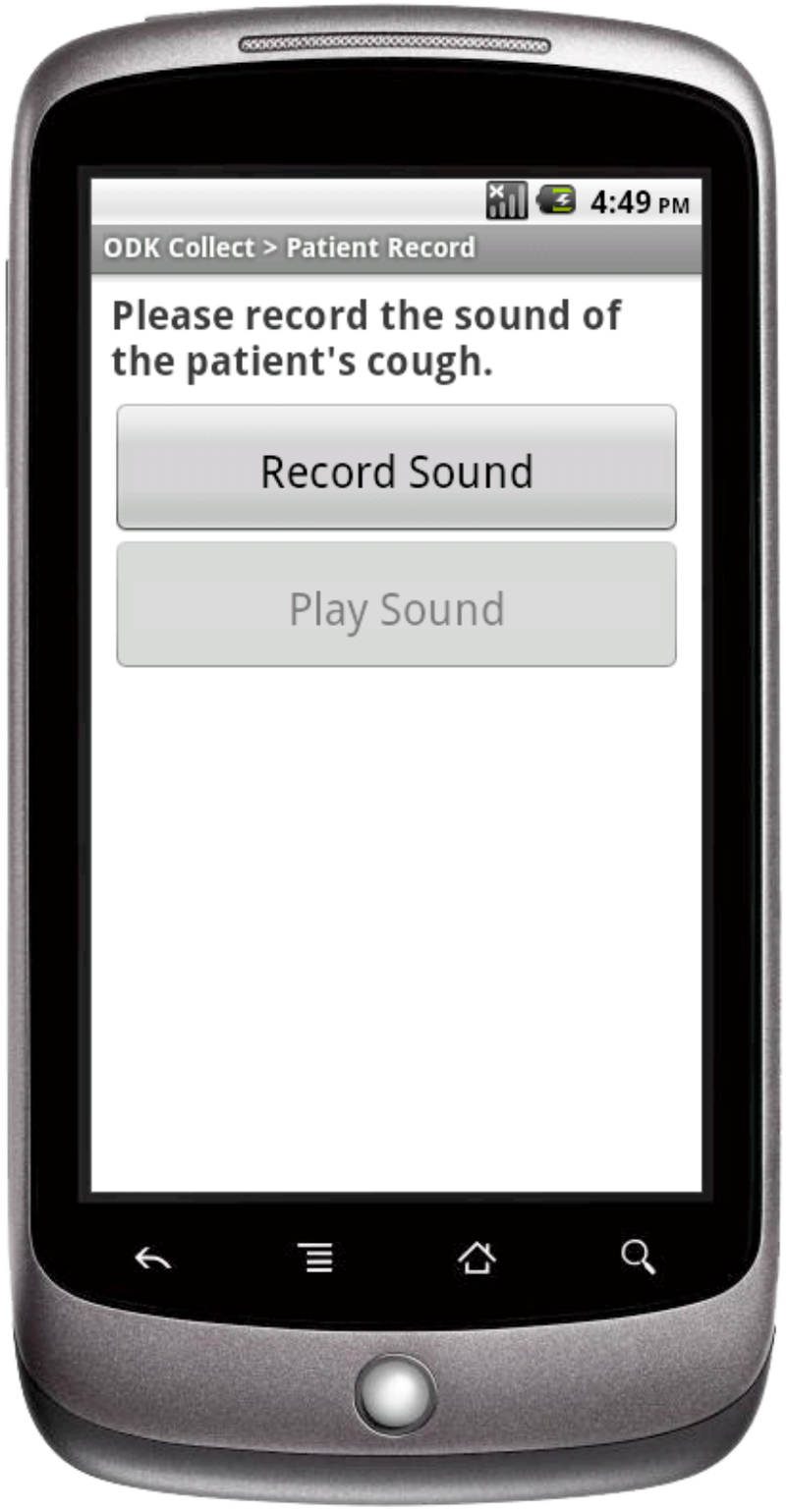
```
        <instance>
            <data>
                <name/>
                <date/>
                <location/>
                <picture/>
            </data>
        </instance>
        <itext>
            <translation lang="eng">
                <text id="/data/name:label">
                    <value>Enter the head of household's full name</value>
                </text>
                <text id="/data/date:label">
                    <value>Enter the head of household's birth date</value>
                </text>
                <text id="/data/location:label">
                    <value>Capture the GPS location of the house</value>
                </text>
                <text id="/data/picture:label">
                    <value>Record video of a walk around the house</value>
                </text>
            </translation>
        </itext>
        <bind nodeset="/data/name" type="string"/>
        <bind nodeset="/data/date" type="date"/>
        <bind nodeset="/data/location" type="geopoint"/>
        <bind nodeset="/data/picture" type="binary"/>
    </model>
</h:head>
<h:body>
    <input ref="name">
        <label ref="jr:itext('/data/name:label')"/>
```

Collect: Display prompts for data collection and delivery



Collect: Render prompts for data collection and delivery





Collect: Extensible architecture built on Android

Aggregate: Host data and provide extraction interfaces

ation-Latitude	Location-Longitude	Location-Altitude	Location-Accuracy	Des
374240020636755	151.1692304632708	28.0	5.0	End other side
37486958941743	151.1690486118154	29.0	5.0	Willow
37504302300135	151.16903599729017	29.0	5.0	Cigarette dump
375864156698455	151.16889189846407	28.0	5.0	Wite flowers
37685209640148	151.1684238513032	28.0	10.0	Trees
37923633851942	151.16784138112294	40.0	5.0	Start white creek
9163298333333	-105.22232958333333	1633.1	12.0	Eddy at dog park
26413130760193	-80.32614648342133	1.0	4.0	Baseball fieldin trop
37890696525574	151.16791605949402	28.0	6.0	Whites creek algae
4937171666667	-121.93441071666666	27.4	3.0	Bob at Santa Clara
37871921062469 5	151.1679643392563	21.0	3.0	White creek running
37857973575592	151.16811990737915	25.0	3.0	Rubbish
37859582901001	151.16813600063324	28.0	3.0	Blue tongue lizard
4937171666667	-121.93441071666666	27.4	3.0	Bob at Santa Clara
9163298333333	-105.22232958333333	1633.1	12.0	Eddy at dog park
26413130760193	-80.32614648342133	1.0	4.0	Baseball fieldin trop

Aggregate: Codebase runs locally and in the cloud

flickr: theplanetdotcom

Aggregate: Designs database backend using XForm

(MySQL 5.1.41-3ubuntu12.6) openmrs/mysql/event — SSH Connected

mysql — Select Database

Structure | Content | Relations | Table Info | Query | Table History | Users

Filter

- db
- event
- func
- general_log
- help_category
- help_keyword
- help_relation
- help_topic
- host
- ndb_binlog_index
- plugin
- proc
- procs_priv
- servers
- slow_log
- tables_priv
- time_zone
- time_zone_leap_second
- time_zone_name

Field	Type	Length	Unsigned	Zerofill	Binary	Allow Null	Key	Default	Extra
name	char	64	☐	☐	☐	☐	PRI		None
body	longblob		☐	☐	☐	☐		NULL	None
definer	char	77	☐	☐	☐	☐			None
execute_at	datetime		☐	☐	☐	☑		NULL	None
interval_value	int	11	☐	☐	☐	☑		NULL	None
interval_field	enum	'YEAR','QUAR…	☐	☐	☐	☑		NULL	None
created	timestamp		☐	☐	☐	☐		CURRENT_T…	on update …
modified	timestamp		☐	☐	☐	☐		0000-00-0…	None
last_executed	datetime		☐	☐	☐	☑		NULL	None
starts	datetime		☐	☐	☐	☑		NULL	None
ends	datetime		☐	☐	☐	☑		NULL	None
status	enum	'ENABLED','DI…	☐	☐	☐	☐		ENABLED	None
on_completion	enum	'DROP','PRES…	☐	☐	☐	☐		DROP	None
sql_mode	set	'REAL_AS_FL…	☐	☐	☐	☐			None
comment	char	64	☐	☐	☐	☐			None
originator	int	10	☑	☐	☐	☐		NULL	None
time_zone	char	64	☐	☐	☐	☐		SYSTEM	None

INDEXES

Non_unique	Key_name	Seq_in_index	Column_name	Collation	Cardinality	Sub_part	Packed	Comment
0	PRIMARY	1	db	A	NULL	NULL	NULL	
0	PRIMARY	2	name	A	0	NULL	NULL	

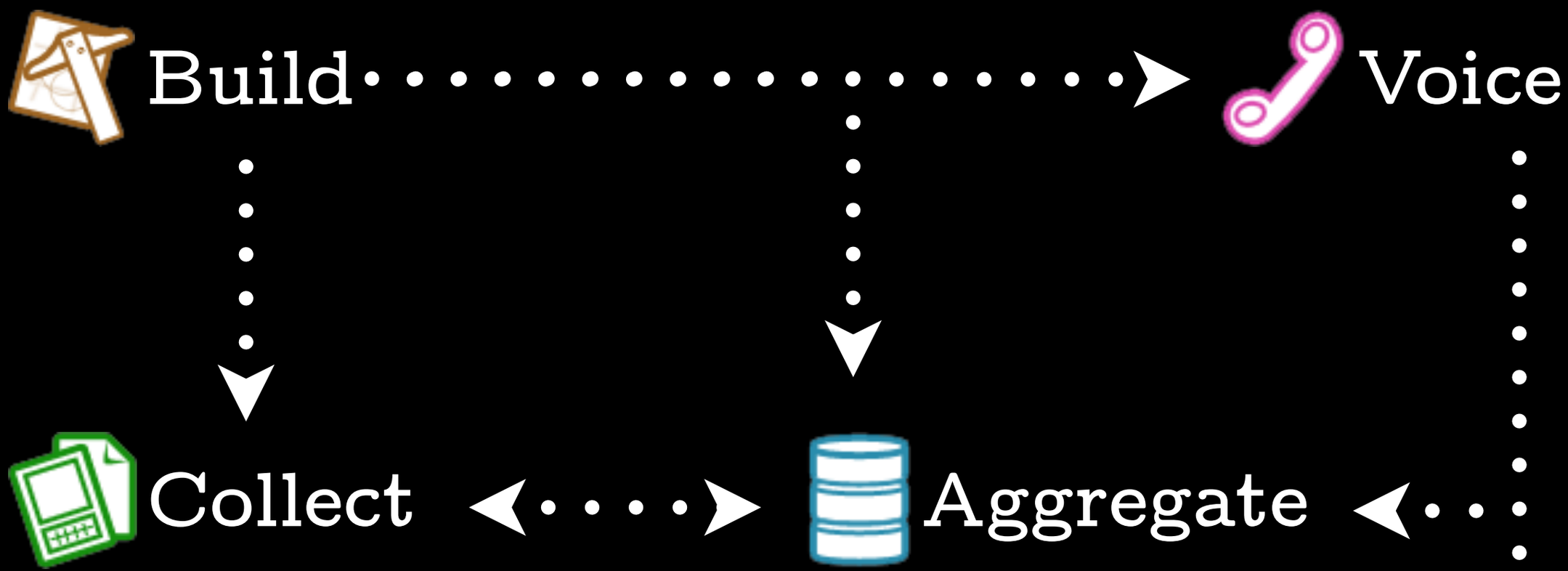
TABLE INFORMATION

- created: 8/18/10
- updated: 8/18/10
- rows: 0
- size: 0 B
- encoding: utf8

Aggregate: Stores or forwards data to external systems

DeviceId	351676030226627
SurveyorName	Shadrack
TreeLocation-Latitude	-4.9192410707473755
TreeLocation-Longitude	29.60762321949005
TreeDBH	57.0
TreeName	Myombo
TreePicture	View

ODK Ecosystem: Tools designed to fit together



Deployments: Over 10-50k users of ODK tools around the world

A group at the University of Washington exploring how technology can improve the lives of underserved populations.

http://change.washington.edu (@uwchange)

multilearn

an educational platform for shared computing environments

MultiLearn applies the use of **multiple keypad input** for effective **shared computing** applications to improve education in environments where **one computer per student is economically infeasible**.

Building upon prior work including MultiPoint and MetaMouse, MultiLearn is a **multiplayer collaborative educational platform** that offers a richer student experience than even single-user models can provide.

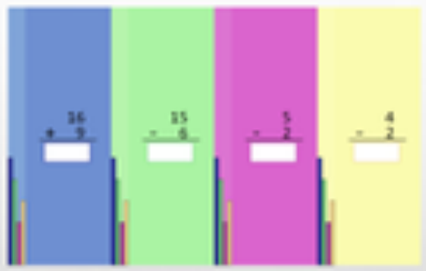
MultiLearn lets teachers easily **create** their own on-screen content, **quizzes** students using **adaptive questioning**, and provides **analysis** of results to teachers. This complete content loop allows for dynamic locally-relevant **custom curriculum**, and **responsive iteration** by teachers based on student performance.

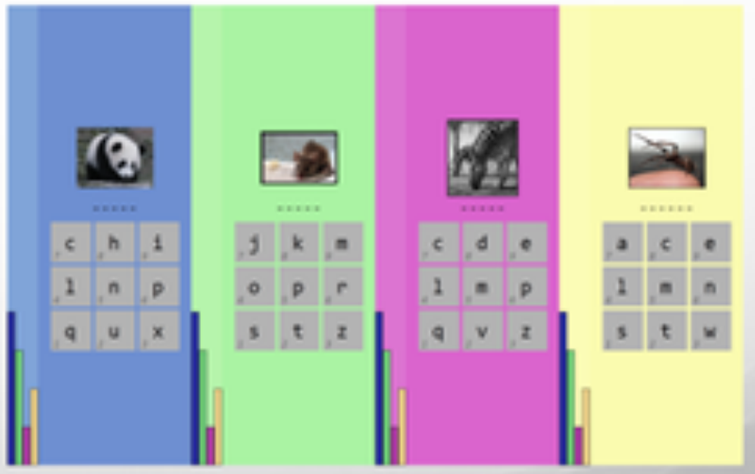
a complete content loop

technical implementation

To maximize compatibility with existing computers, MultiLearn is built using the .NET Framework. It supports off-the-shelf numeric USB keypads which can be purchased at very low cost (approximately $4).

Multiple input devices are supported via the Windows RawInput API. Problem sets are defined in XML and packaged with associated graphics into a ZIP-based file format for portability between machines, and student performance is logged in real-time using SQLite.





a cse capstone project by

sunil garg charlotte robinson clint tseng heather underwood

CIS CENTER FOR INFORMATION & SOCIETY

change

Midwife's Ultrasound

Problem

Maternal mortality rates in the developing world are unacceptably high. Many of these deaths are preventable if potential pregnancy complications are detected early.

Although many complications (e.g. placenta previa, breech presentation, multiple gestations) can be diagnosed easily with ultrasonic imaging, most ultrasound machines are prohibitively expensive for the developing world and require extensive medical training to operate.

Research & Fieldwork

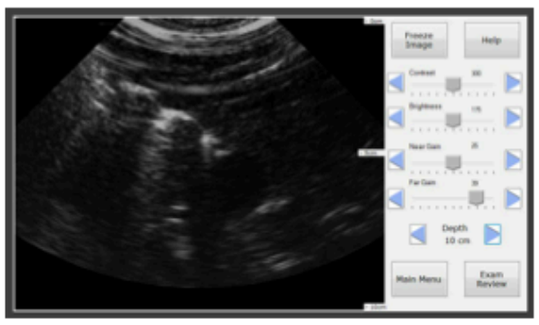
To inform our design we sent paper surveys to Ugandan midwives participating in a UW Radiology ultrasound training program. The survey identified unnecessary and difficult to learn ultrasound features of existing devices. Two Ultrasound instructors verified the difficulty of these ultrasound concepts.

Additionally, local midwives, ultrasound technicians, and radiologists from the UW Medical Center and Harborview Medical Center provided feedback about the suitability and usability of the prototype.

Interface for Midwives

Midwives are often central medical figures within decentralized communities; supporting their work practices will in turn support the health and development of rural communities as a whole.

We created a user interface (UI) designed specifically for midwives that excludes features they are unlikely to use in rural Uganda.



Portable Ultrasound

Our prototype device includes a USB ultrasound probe (Interson AB 3.5 MHz), a touch-screen netbook, and a custom UI that provides an approachable interface for the midwives.

Most commercial ultrasound devices cost upwards of $20,000. By integrating a commodity USB ultrasound probe with a netbook, our current prototype costs only about $3,500.

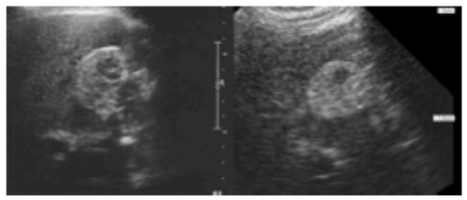


Image of liver obtained using standard ultrasound machine in hospital radiology departments (left) and our prototype (right).

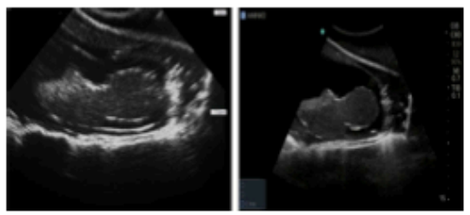


Image of 17-week fetal phantom obtained using our prototype (left) and using SonoSite M turbo ultrasound machine (right).

Future Goals

- Perform scans on pregnant women to verify image quality.
- Expand UI functionality to include a contextual help system, a patient data record browsing system, and improved scanning functionality.
- Reduce system cost to <$1000.
- Perform usability testing with Ugandan midwives.

Waylon Brunette Wayne Gerard Pratik Prasad Gaetano Borriello Ruth Anderson
Matthew Hicks Alexis Hope Beth Kolko Rob Nathan

HCDE Human Centered Design & Engineering

change

UW Medicine

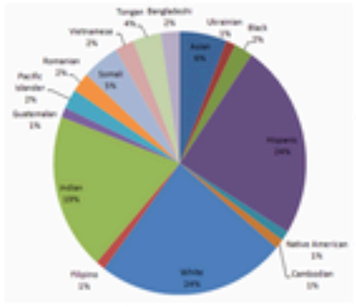
Using Smartphones to Overcome Language and Health Barriers

By Jared Clement (CSE), David Cohen (CSE), Steve Naranjo (HCDE), and Khadija Qader (HCDE)

Challenges Close to Home

In the Tukwila–SeaTac area, compared to King County averages:

- Life expectancy is seven years shorter
- Residents have little or no access to basic health services and economic opportunity
- Number of households below the poverty line is 76% higher
- 11% of residents do not speak English at home



Ethnicity of Patients Who Visited New Hope Health Center in Tukwila

Global to Local

The Global to Local Initiative (G2L):

- Building on the expertise of Washington State's global health institutions
- Bringing home strategies that have proved effective in addressing health in developing countries.

SWEDISH
Public Health Seattle & King County
HealthPoint
Washington Global Health Alliance

Our Solutions

Over-the-Phone Community Interpretation

Step 1 - Client sends SMS to service from any cell phone

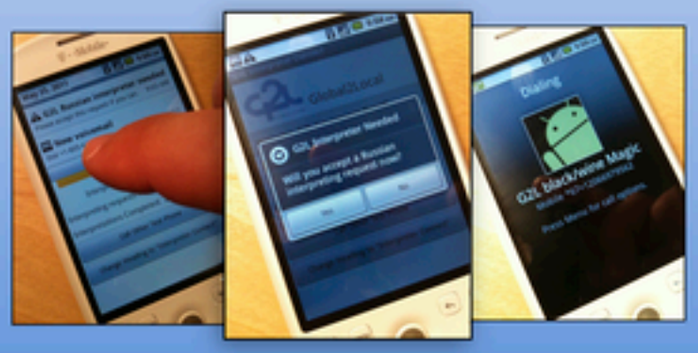
Step 2 - SMS fielded by server, which finds available interpreters (or responds to client explaining upcoming availability)

Step 3 - Server sends SMS to available interpreters, who have Android phones running our application

Step 4 - Application on interpreters' phones gets SMS and displays request

Step 5 - Interpreters confirm or reject request. First confirmation back to the server wins.

Step 6 - Server sends phone number of the client to winning interpreter, and interpreter's Android phone places call back to client (client's phone sees blocked Caller ID, not interpreter's phone number).



Diabetes Screening (Open Data Kit)

Encouraging preventive care: Diabetes risk screening by community health workers

Mitigating language barriers: Over-the-phone interpretation by community volunteers

ODK Tables

Jeremy Lenz, Julia Chu, Yoon Sung Hong

Motivations

- Mobile as platform for data management
  - Available to 90% of the world population and 80% of population living in rural areas
- Mobile-to-Mobile data communication
  - Addition and query to the database through SMS/GPRS

Interactive Demo

What would you name your child?

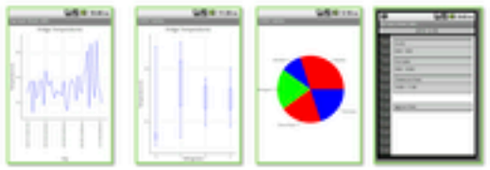
Send SMS to 206-962-0964

1) **Female Child**
   - @child +n YOUR_CHILD_NAME
   - Ex) @child +n Mary
2) **Male Child**
   - @child YOUR_CHILD_NAME
   - Ex) @child Joe

Design & Features

- Cloud database on a smartphone
- Managing data using table model
- Transferring data through SMS

Visualization



Organizing Table

Indexing

Collection-View

Access Control

- Read/Write groups
- Password protected
- Filters SMS additions and queries by access groups and matching passwords

Import/Export

- CSV import/export to the local storage
- Backup and restore from cloud database

Use Cases

Data Collection Only

Survey

Q: What is your favorite coffee?

A: @Coffee {Americano, Latte, Cappuccino, Mocha}

Classroom

Replacing clickers in INFO200 class (30-45 students):

- Yes/No
- Multiple Choice
- Free Answer

Data Collection and Dissemination

Market Place

Replicated a study from The Quarterly Economic Journal. The price table that fishermen can make query for prices while at sea, and market agents to update prices info.

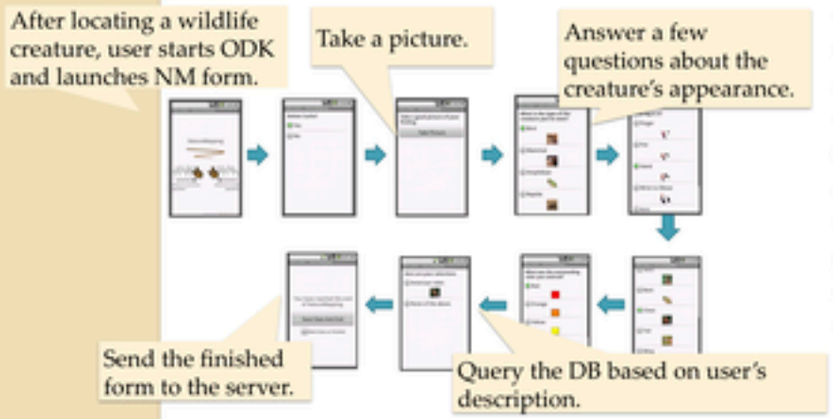
Assign Tasks

Manager assigning tasks to workers using SMS. Workers view the tasks on ODK Tables.

NatureMapping

Chiyoung Song, Tatsuro Oya, Kevin Bang

Usage Scenario



ODK (Open Data Kit)

- User selects a form to fill in.
- ODK parses the form, and renders the question on the screen.
- User answers the rendered questions.
- Finished form is saved, ready to be submitted to a server.
- A very simple but effective data collection tool.

The Problem

- The form requires every data entry pre-defined within it in order to implement decision-tree based selection generation.
- This model WILL NOT SCALE as the database gets larger and larger.

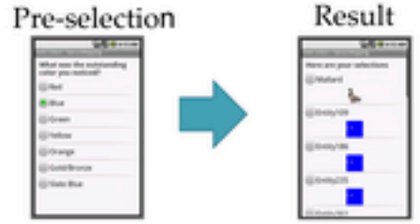
Approach

- User-device interaction will remain the same.
- DB interaction / dynamic selection generation during rendering

Implementation - ODK Collect

•ODK recognizes special question type and special attributes of this type, which indicates question instances to look back.
•When this special question type is encountered, ODK reads the answers to the specified questions.
•Based on these answers, queries the database to get appropriate entries, then display them on screen.
•Result: Separation of data entries from the form!

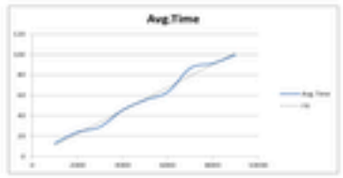
Implementation - Database



- Results from previous questions are used for Database Queries.
- Caches database for future use.
- Cache renewed after timestamp or location-stamp expiration.

Database Performance

The relation between time it takes to update local database and the size of external database is linear.



Implementation – Form Structure

The new form allows us to embed attributes in select tag that can be used to:

- make query
- figure out the location of database
- check for cached entries.

WuhaGize (WaterTime)

John Chilton[1], Kristian Leiberg[1], Rita Sodt[1], Ephrem Yemru[2]

1. UW Computer Science, 2. UW HCDE

"Given the relevance of the time-saving benefit to water supply policy and the fact that the benefit is usually uppermost in the mind of the consumer, it is remarkable how few data have been collected on the amounts of time spent collecting water" Cairncross and Valdmanis, Disease Control Priorities in Developing Countries, **2006**.

Purpose

To support water usage studies in resource poor environments by providing low-cost, low power sensors to measure movement.

Image credit: Professor Joe Cook, University of Washington

System Components

- Motion detecting sensor
- Android app to manage sensors and collect data
- Python program to sync phone data to computer

System Use: Three Phases

1) Deploy

- Assign sensors
- Conduct survey

2) Collect

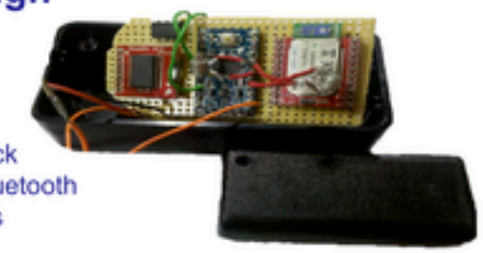
- Pull data from sensors to phones

3) Sync

- Pull data from phones to computer

Hardware Design

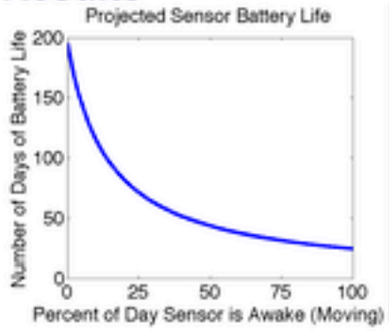
- Arduino Pro Mini
- Real-time clock
- EEPROM
- Bluetooth
- Two AA Battery Pack
- Switch to power Bluetooth
- 2 Mercury Switches

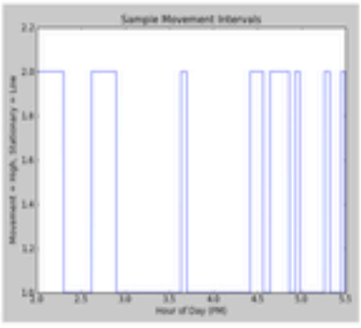


Optimizations

- Reduce noisy data: Motion detection algorithm on sensor (minimum movement time and max. idle time of two minutes)
- Reduce power usage: Low power sleep modes used when sensor is not moving

Results





If the sensor moves 25% of the day and if researchers collect data via Bluetooth once a week the sensor is projected to last over two months on two AA batteries, as shown on the graph on the left. The histogram on the right shows movement intervals detected by the sensor during a week long period.

Conclusion

Successes:

- Battery Life
- Data Quality
- Size/Weight
- Cost (projected)

Areas for Improvement:

- Extensibility

Future Work:

- Send prototypes to Ethiopia to be tested
- Create custom PCBs
- Bring down cost for full deployment

Acknowledgements

Special thanks to Profs. Anderson, Borriello, & Kolko, Rohit Chaudhri, Prof. Joe Cook & Yuta Masuda, and HCDE student Rachel Reynard

Combating HIV by Making Breast Milk Pasteurization Safer

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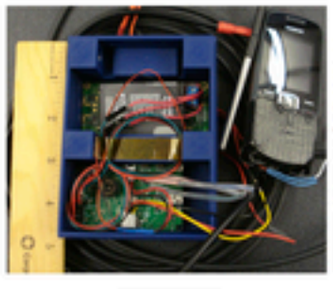
Problem

- The infantile HIV rate in South Africa is higher than any other country
- 40% of babies are infected with HIV through their mothers breast milk
- Pasteurizing breast milk before feeding it to infants is a way to prevent transmitting the virus
- However, current milk pasteurization methods have little or no quality assurance

Guided Pasteurization

1. "Reading Temp" – temperature of the milk is being monitored
2. "Almost Done" – temperature of the milk is nearly hot enough to kill HIV
3. "Remove from Heat" – milk has reached critical temperature and jar should be moved to cold water
4. "Cooling" – temperature decreasing
5. "Wait for Approval" – data is sent to QA for analysis and response
6. Result – milk is or is not safe for use

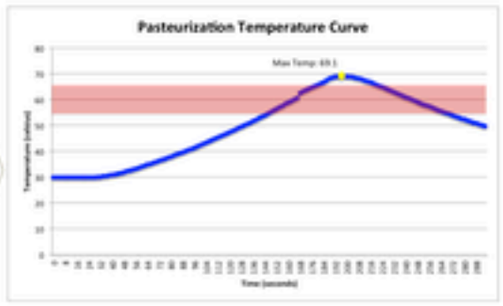


Solution

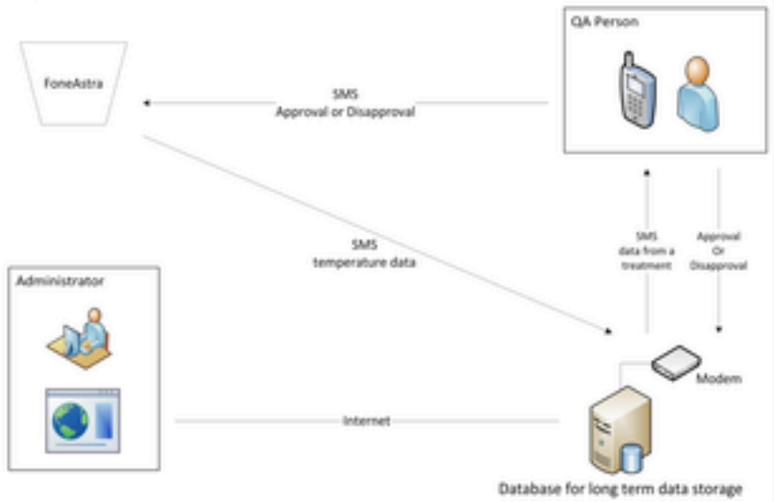
The temperature monitoring device is an adaptation of FoneAstra. The device collects temperature readings from the connected probe and uses the phone to SMS them to the server. The device uses an LCD screen, red and green LEDs, and a buzzer to guide the user through the pasteurization process.

A netbook server with a modem forwards temperature data to QA via SMS and stores the data and QA response in a database. The server also has a webpage that gives graphical views of any data set from the archive (pictured at right).

The QA application runs on an Android phone. It intercepts SMS from the server and displays a temperature curve and data summary. The QA reviews these and selects the "Approve" or "Disapprove" button, which sends a response to the device and server.



System Data Flow



Future Work

- Improvement to the case of the monitoring device
- Expand monitoring device functionality so it can perform multiple flash heating processes without having to receive a response from the QA
- Beta testing of the whole system in South Africa and analysis of the data collected and the research being conducted at PATH
- More sophisticated web dashboard for an administrator accessing the server
- A cheaper LCD screen integrated with the monitoring device

PATH
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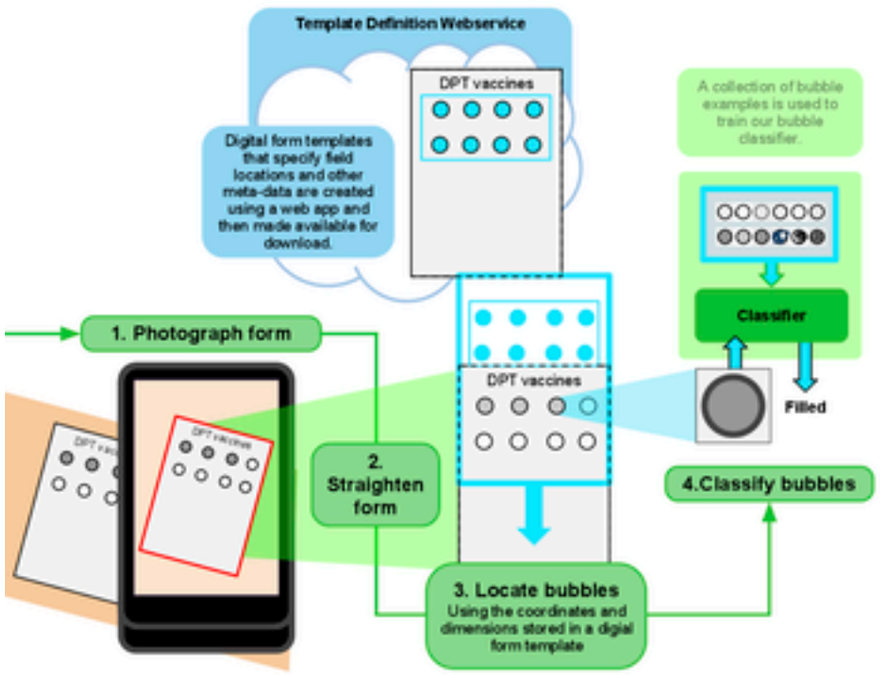
Usage Scenario

- Rural health clinics in Mozambique need to gather data for inventory management and WHO monitoring
- They use paper forms which periodically need to be *hand* transcribed
- Using an electronic device for data capture will speed up data aggregation

System Architecture

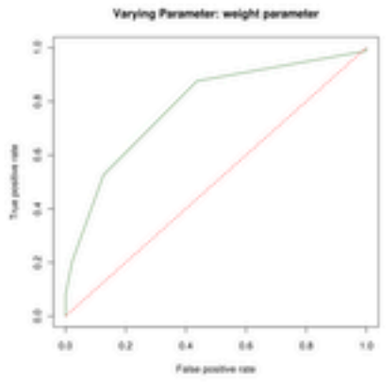


Training Classifiers

- Bubble classifiers are trained with examples of filled and empty bubbles
- This training provides the basis for bubble detection in all forms

Results

- A test suite creates ROC curves to measure classification accuracy
- Good classifiers make curves far to the left of the main diagonal



Looking Forward

- Improve form straightening and alignment
- Compare phone camera with handheld scanner
- Rigorous testing of different bubble classifiers
- Scanning of handwritten numbers
- Interoperability; serializing data in standardized formats

Mobile test analysis to improve diagnosis at the point of care in developing countries.

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