SATELLIFE

Uganda Health Information Network

September 2003 – Present

Summary of Achievements, Challenges and Way Forward

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1. Introduction

Uganda Health Information Network (UHIN) is a joint project of SATELLIFE, its sister organization, Uganda Chartered HealthNet (UCH)[1], the Makerere University Faculty of Medicine, and Connectivity Africa[2] of the International Development Research Center (IDRC) of Canada[3].

The main objective of UHIN is to help improve healthcare service delivery to the Ugandan population by improving health workers' access to health and medical information and supporting data collection and analysis through the use of handheld computers, also known as Personal Digital Assistants (PDAs) interfaced with the local GSM/GPRS cellular telephone network via Wireless Access Points (WAPs).

The Uganda Health Information Network (UHIN)[4] is the largest and most ambitious handheld computer project SATELLIFE has undertaken to date, incorporating a new, previously untried element: digital networking of geographically dispersed handheld computers via the local GSM cellular telephone network to support the two-way transmission of information and data. Only three years into this project, over 160 remote facilities serving more than 1 million people that have no Internet access and, in some cases, not even electricity, are able to send and receive regular transmissions of desperately needed information and accurate, actionable data. For Uganda, which has one of the highest burdens of disease in the world but also some of the best cellular telephone coverage in Africa, the marriage of handheld technology and cellular telephony represents a watershed moment in the battle against information poverty.

Uganda Health Information Network started in 2003 (UHIN Phase-I or UHIN-Pilot) in Rakai and Mbale districts mainly to test the viability of using handheld computers, wireless access point and GSM/GPRS network for establishing robust and easily adaptable information communications

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[1] See website <http://portfolio.ljonn.com/uch/>.
[2] See website <http://www.connectivityafrica.ca/>.
[3] See website <http://www.idrc.ca>.
[4] See website <http://pda.healthnet.org/>.

network. During the period September 2003 – December 2004, SATELLIFE and its partners successfully demonstrated that communication, information access, and data collection and analysis can be significantly improved among health workers at the facility and district level in Uganda through the use of a two-way communication network integrating handheld computers, wireless access points, and local GSM cellular service.

The second phase of the project (January 2005 – March 2006) is based on the successful pilot that demonstrated the viability of integrating handheld computers, Access Points, and cellular network for supporting two-way health information dissemination and data collection.

A total of 350 handheld computers provided by the project are in use by frontline health workers in the160 health centers in the districts of Rakai, Mbale and Manafwa.

2. UHIN Phase-I, September 2003 – December 2004: Achievements and Challenges

Mobile Caching Servers: A High-Tech Concept in a Low-Tech Environment

UHIN Phase-I (pilot) relied on mobile caching servers also known as "Jacks" to transmit data over the cellular network. These devices, produced by WideRay, Inc.[5] of California, are self-contained, battery-operated, Linux-based computers containing a cellular modem and a large memory cache. End users connect to the caching device using the infrared beam of their handheld units. The caching devices in turn communicate with a central server in Kampala via the GSM/GPRS cellular network. Data collected in the field on a handheld computer can thus be uploaded to the caching device via infrared beam, stored on the cache until a regularly-scheduled, off-peak call is initiated, then transmitted to the central server via the cellular network. Information and data flow equally smoothly in the opposite direction, so that when an end user uploads data to the caching device, he or she may also receive the latest news, clinical articles, continuing medical education materials, or virtually any other type of content that can be exchanged digitally.

When SATELLIFE and its partners pioneered this technology in 2003, they found themselves once again looking at some basic questions: Would this technology that had never been tested in Africa function reliably? Would end users not only learn and use the technology, but also find it useful for their daily work? Would UCH be able to acquire the capacity to support the network without SATELLIFE's ongoing involvement? How much ongoing technical support would end users require

[5] See website <http://www.wideray.com>.

after their initial training? What kind of start-up costs and ongoing operating costs would be incurred? Could the network be sustained after donor funding was exhausted?

These questions were addressed in Phase One of UHIN, during which nine Jacks were installed throughout Mbale and Rakai at health facilities that commonly consist of no more than a dirt-floor room with a table and chair. Handheld units were distributed to 200 individuals. Also during Phase One, Uganda Chartered HealthNet built its internal capacity to train end users, develop electronic data collection forms, and manage the network.

From its inception, the network was used for both information dissemination and data collection. Regular broadcasts initiated by UCH have featured:

- health information from SATELLIFE's information services
- continuing medical education and health updates on malaria, HIV/AIDS, and tuberculosis
- treatment updates
- general interest news from Uganda's mainstream media

In addition to receiving all this content, field level health workers use their handheld computers for data collection employing the MOH's Health Management Information System (HMIS) Form 105 and Form 033 for routine reporting.

UHIN Delivers Significant Results

Within months of deployment, UHIN began producing measurable results:

- A cost effectiveness analysis of the first six months of the project, during which time only two of the fourteen paper forms used by the districts had been converted to the electronic format, showed that the network delivered a 24 per cent savings per unit of spending over the traditional manual data collection and transmission approaches, a figure likely to increase when additional paper forms are converted. [6]
- Rakai and Mbale District Health Services reported obtaining close to a 100 per cent compliance rate with their weekly Disease Surveillance reporting using the network, whereas the national average is 63 per cent.
- The districts reported benefits including improved data quality at point of collection, more timely access to data for analysis and decision-making, and more rapid response to emerging situations.

[6] SATELLIFE. "Draft: Cost Effectiveness Study Report for the PDA Data Capture and Transmission." Sept. 2004. 19 July 2005. <http://www.healthnet.org/coststudy.php>.

- Health workers at remote sites, even those with no fixed telephone lines or regular supply of electricity, routinely access critical information, including continuing medical education materials, which had previously been unavailable to them. They no longer have to travel long distances to the district headquarters to deliver data or to receive feedback, conserving time and resources for the health system.
- UCH not only acquired new staff and new technical and training capabilities, but also developed realistic strategic and business plans that forecast sustainability based on its ability to deliver connectivity, training, and content on a fee-for-service basis to other NGOs, government agencies, and institutions.

Constraints & Solutions

The project partners encountered several challenges that presented excellent learning opportunities:

- *Power*. An unreliable power supply initially plagued many users who were unable to recharge their units as needed. The partners tested a variety of solar chargers and in general found them to be very cost-effective and reliable. Solar charges are currently used in sixty locations. The partners will continue to explore solar power options with the goals of defining minimum specifications for a standard device and identifying an Africa-based producer.
- *Mobile Caching Servers*. The first model of caching devices (Wideray G20) tested in Uganda was prone to dropping calls or failing to connect or disconnect. When files reached the central server, UCH staff had to open them manually to determine where the data needed to be sent. A decision was made to upgrade the system to a newer model (SP320) with more memory that proved to be far more stable in the field.
- *Data Collection Software*. Once it was established that the mobile caching servers could interact with the GSM cellular network, the partners tested the network's ability to transmit standard data collection forms mandated by the MOH and used at health centers throughout Uganda. The form-generating capacity of WideRay's software meets basic needs, but lacks the degree of sophistication and flexibility required for the MOH forms. One form alone has over 300 fields, many requiring branching. Consequently, the partners had to identify alternative forms development software compatible with the store-and-forward data transmission protocols utilized by the WideRay system. The project partners found the Perseus software program to meet most, but not all, of the network's needs and will continue to explore options that provide more functionality, allow cumulative reporting in the field, and facilitate the conversion of additional paper-based forms to the electronic format.
- *Training*. After trying a variety of training formats, UCH found residential training to be more effective than work-site training, especially when conducted over two days with small groups

of up to 20 participants. In order to build local training capacity, appraisal mechanisms were used to identify the most highly motivated and competent users who could become district based trainers or provide user support to their colleagues.

3. UHIN Phase-II, January 2005 – March 2006

The second phase of UHIN is built on the successful pilot that enabled the partners to demonstrate the viability and cost effectiveness of integrating handheld computers, Wireless Access Points, and cellular telephony into a network capable of supporting two-way health information dissemination and data collection.

Phase Two of UHIN, that ended in March 31, 2006, entailed expansion of the network to 160 health centers in Mbale, Manafwa[7], and Rakai districts. The overall goal is to support the second Health Sector Strategic Plan (HSSP) of the Ministry of Health of Uganda and contribute for the reduction of morbidity and mortality of the population from major causes of ill health by establishing an effective two-way electronic communication system for the delivery of timely, accurate and relevant information and developing data collection and transmission tools that will contribute to the improvement of the standards of national healthcare.

The project partners have also set an ambitious agenda to study and disseminate the lessons learned from UHIN in order to promote global understanding of how emerging technologies can be leveraged to bridge the knowledge gap between rich and poor countries. Key considerations for UHIN Phase-II included:

- In communities where UHIN is used by local health workers, how does their access to information impact the quality of healthcare service delivery to the population?
- What are the requirements for moving beyond the pilot phase to a full national roll-out of the technology?
- What additional complementary technologies can be integrated into the network to maximize its reach and functionality?

These are some of the issues that are being addressed in Phase Two of UHIN, during which ten Jacks were installed at health centers throughout Mbale, Manafwa and Rakai. Handheld units were distributed to 150 health workers (350 total, including 200 handhelds in Phase-I).

[7] Mbale district was split into two district, Mbale and Manafwa, in 2005

Key intervention during this phase was delivering relevant health information addressing crticial health problems to frontline health workers. The partners identified, formatted and transmitted relevant health information to practitioners in response to user needs in Rakai, Mbale and Manafwa districts. UHIN regularly broadcasted relevant health content to doctors, senior nurses, and senior clinical officers ("tier-1"), and to community health workers ("tier-2"). Intensive and focused content is delivered via PDA to both tiers of health workers addressing diarrhea on Mondays, pneumonia on Wednesdays, and malaria on Fridays. Additional content on other relevant topics were identified for transmission at regular intervals in response to immediate user needs. For example, in November 2005 there were 37 cases of epilepsy reported in Mbale district, triggering a huge demand from health workers for health content on the treatment of this disorder. SATELLIFE, in collaboration with UCH, identified relevant content for the diagnosis, treatment, and care of epilepsy patients; this information was broadcast on December 2005.

SATELLIFE and UCH formed a team composed of leading researchers and scientists from Faculty of Medicine , Makerere University and Economic Policy Research Center to measure the impact of improving practitioners' access to relevant health content on improving clinical decisions. The impact assessment is designed to measure to what extent the improved flow of information and data critical to the health care system improves decision making at all levels of the system and the quality of health service delivery to the population. Studies in the developed world have shown that physicians make changes in their clinical approach and in the advice that they provide patients when they have access to and consult relevant literature. The practice of CME in low resource settings, while understood as important, is hampered by the lack of locally relevant content, the time and cost required to attend training sessions, and the appropriateness of the training for the different levels of health care workers actually providing care.

Preliminary findings of the impact assessment indicate that consistent access to CPD materials is resulting in an improved quality of service to the local population. A study to assess the impact of UHIN in improving quality of health care in Rakai and Mbale districts revealed the following preliminary results:

- Health workers in Rakai and Mbale districts are providing improved clinical care to patients with malaria and diarrhea as a result of receiving health information broadcast through the network

- Health workers are referring to the literature available in their handhelds, including national treatment guidelines, for their daily practices.
- Over 50% of health workers surveyed rated information accessed through their handhelds as useful at all stages of patient care, including diagnosis, treatment, and advising patients on home-care.
- There is increased health worker and client satisfaction with services provided at health facilities in February 2006 compared to the baseline survey conducted in June 2005.

Improving HMIS Data Quality and Timeliness: UHIN partners converted HMIS and non-HMIS forms for electronic data capture using handheld computers and transmission over cellular network to District Health Offices from remotely located health centers. Data collected using paper and pencil is prone to transcription errors, loss, and damage and takes time to enter into databases, another process prone to human error. Furthermore, the data rarely reach policymakers in time for informed decision making on the basis of accurate epidemiological analysis, due both to the labor-intensive nature of the process and the geographic and technological barriers to data movement within the system. Useful feedback on the data moves in the direction – back to the field – with even less success and frequency. SATELLIFE and UCH addressed these challenges by converting HMIS paper forms to PDA format and training rural health workers to transmit the data through UHIN to district health services.

Evaluations of UHIN Phase II has confirmed that health workers and district health services officials recognize the improved access to health data and medical information and the support given to the health management information system (HMIS) afforded by UHIN contribute to improving provider practices, enhancing healthcare service delivery, and promoting informed decision making. Because they understand the importance of the network for building health system capacity, DDHS and their staff are actively promoting the use of the network to all health workers within the project districts and also to their peers in non-participating districts.

Developing New and Low Cost Technologies: Through IDRC support, SATELLIFE is leading development of a new Wireless Access Point ("African Access Point" or AAP). The AAP is a Linksys WRT54GS based wireless access point capable of deploying content and data exchange via GSM/GPRS upstream internet servers and via IrDA, Bluetooth and/or Wi-Fi to short range proximity devices. The AAP works in a way similar to WideRay Jacks, but unifies more and diverse wireless functionalities such as Bluetooth and WiFi and also supports data

transfer via Ethernet to wired devices such as laptops and desktops. It serves as a distributor of information to the field and a consolidator of information from the field. End users connect to the AAP using the infrared capacity of their handheld units, or via Bluetooth and WiFi if their units have such capability. The AAP can be programmed to make cellular telephone calls to a centrally located server. Content and applications can be provided to the server by locally connected workstations or via the Internet by remotely connected workstations.

The AAP will use open source applications and will cost about $600 per unit and will be ready for deployment on August 2006. The Wideray Jack costs $1,500 and by deploying the AAP in UHIN Phase Three, we will significantly reduce equipment related expenses of the project and deploy more access points in the districts.

4. Survey Results of UHIN Phase-II and the Way Forward (UHIN Phase-III)

Preliminary evaluation of UHIN Phase-II conducted in December 2005 indicated the following results:

- Regular use of PDAs, at least 3 times a week, was observed in 64% of all users (35% of total users use PDAs daily and 29% about three times a week).
- Over 41% of respondents said that they are setting aside money to purchase their own PDAs in case the ones supplied by the project were withdrawn.
- 75% of users indicated that content received through the network is improving healthcare service delivery
- The majority of PDA users are the nursing cadre that includes midwives and nursing assistants located at community health centers (HC-IV, III & II).
- Jacks remain far removed from users with only 50% being with 5 km radius from nearest jack.
- Sixty-eight percent (67.8%) of users regularly access content from the jacks
- The main areas further training is required is related editing of forms (34.7%) and backing-up data on back-up/ expansion cards (16.5%).
- Users are regularly supervised by both the district supervisors and technical team of UHIN.

The preliminary evaluation also identified areas in which UHIN can be improved. While regular use of PDAs by health workers stands at a reasonably good level, over 50% of the wireless relay devices are located at distances more than 5 km from the end users' health centers and over 25% at distances

more than 10 km, adversely affecting the frequency of network utilization for content download and HMIS transmission. In addition, while all users have received basic training in PDA and data collection forms use, most are not conversant with higher-level PDA functionality, such as backing up data. Even though end user response indicates that the content delivered is relevant and UHIN has been able to rapidly respond to requests for specific information, there is an expressed need to increase the range of content to include information on medicines, HIV/AIDS, and common diseases and medical conditions.

5. UHIN Phase-III

In addition to having developed the capacity of health workers throughout the three districts, the implementation of UHIN over the past three years has built the capacity of the project partners to design, develop, deploy, and support advanced information and communications technology projects. Therefore, based on the success of UHIN Phase-II in improving the flow of information both from the health centers to the DDHS and MOH and from central management to the frontline health worker, the project partners are now prepared to further expand and enhance the network.

Grant agreement between SATELLIFE and IDRC has been signed on June 9, 2006 for the implementation of UHIN Phase-III. The project will run for a period of 12 months. The primary goals of the UHIN Phase-III are 1.) to strengthen health information systems by expanding UHIN services for the transmission of health information and HMIS data exchange to all health centers in the districts; 2) to support DHS to make informed and prompt decisions by increasing the accuracy and timeliness of health data received from field health workers; 3) to test, evaluate, and improve an African-developed wireless access point; 4.) to continue impact assessment of the network on the quality of health service delivery as a result of health professionals' improved access to current information and continuing medical education; 5.) to identify and document best practices and lessons learned from the project for replicating the network in other districts in Uganda or elsewhere in Africa; and 6.) to assess cost effectiveness of the network for HMIS data transmission.