Computing and the Developing World

CSEP 590B, Spring 2008
Lecture 3 - Telemedicine
Richard Anderson

Administration

• Reading assignment
• Supplementary Readings
• Authentication
  – User: csep590b
  – Password: student

Today’s class

• Kiosk Summary
• High Bandwidth, High Latency Internet
  – Data Muling
• Telemedicine
• Wireless Long Distance Internet

Highlights from Lecture 2

• Internet connectivity
• Kiosk Applications
  – Financial Contribution
  – Social Impact
• Case studies
• Viability of Kiosks
  – Income generation too low

Kiosk Summary

• Holy Grail of ICTD
• Two fundamentally different cases
  – Build down from economic viability
    • Akshaya
  – Build up from nothing
    • LinkNet

Remote Internet Access

• Technology Questions
  – Method of Connection
  – Level of service
    • Bandwidth, Latency, Reliability
  – Cost
• What are the connectivity demands of different applications
Can the internet create rural business opportunities?

Traditional Crafts Marketing
- Is a “direct from the village” internet based traditional craft business viable? Why or why not.

Technology Case Studies

Sneaker Net
- What is the bandwidth of a single DVD carried between Africa and the US?

DakNet
- MIT Media Lab, First Mile Solutions, United Villages
- Ideas
  - High latency connectivity sufficient for many applications
  - Vehicle based transport
    - Rely on regularly scheduled transport
  - Automatic wireless data transfer

System model
- Vehicle has “Mobile Access Point”
- Kiosk has wireless access
- When vehicle in range of kiosk, data is exchanged
- Cost and power are low
- Leverage existing transportation routes
Orissa Pilot, Busses

- Advantages of public busses
- Disadvantages of public busses

Cambodia Pilot

- Internet connectivity for AAfc/JRF schools
  - 250 schools with computers
  - Pilot for 15 schools
- Motor scooters used to carry MAPs
- Costs
  - 15 schools with VSAT: USD 260,376
  - DakNet to share 1 VSAT: USD 39,979

KioskNet

- S. Keshav, University of Waterloo
- Minimum cost kiosk
- Target: $100 PC (aka recycled PC)
- Address
  - Low cost
  - Low power
  - Recycled PCs
  - Minimum maintenance
  - Connectivity

Full system deployment

- Kiosks
  - Low cost computers with Kiosk Controller
- Ferries
  - Mechanical Backhaul
- Gateway
- Proxy
- Legacy Server

Technical Challenges

- Implementation of Delay Tolerant Networks (DTN), Integration with services
- Security model, Public Key Infrastructure
- Support boot from Kiosk Controller
- Maintenance
  - Secure software update integrated with data ferry

Kiosk Summary

Open issues

- If you could fund a Kiosk Research Project what is the problem you would have the project investigate?
The Challenge of Telemedicine

Tiered Health Care
- Teaching Hospitals
- Regional Hospitals
- District Hospitals
- Health Centers
- Health Post

From the readings, what are the three most important problems addressable by ICT?
1. 
2. 
3. 

Important problems (summary)
1. 
2. 
3. 
4. 
5. 
6. 

Telemedicine
- "Telemedicine is the ability to provide interactive healthcare utilizing modern technology and telecommunications"
- Specialist referral
  - You have a bad sore throat
  - Primary care physician arranges remote consultation with ENT specialist
  - Audio video conference with medical records available to the specialist
  - Special equipment – nasalpharyngoscope for real time imaging sent to specialist
  - Facilitate scheduling and travel
  - Primary care physician participates

Usage models
- Real-time
  - In or outpatient specialty consultation
  - Physician supervision of non-MD Clinician
- Store and Forward
  - Teleradiology
  - Images scanned, direct capture, digital camera
  - Dermatology, Ophthalmology, Pathology
- Home Health Telemedicine
  - Disease management
  - Assisted Living
Telemedicine in the developing world

- Generally considering a broader problem
  - How can ICT improve care in remote regions
- Spanning greater divides
  - Travel time
  - Economic differentials
  - Expertise differences
- Constraints
  - Network connectivity
  - Electricity and other infrastructure
  - Financial

Notable projects

- Aravind Eye Hospital
  - Remote exams through mobile van
  - Image based detection of diabetic retinopathy
- Black Lion Hospital, Addis Ababa, Ethiopia and Care Group Hospitals, Hyderabad, India
  - Expert consultation
  - Medical education
  - Fiber optic and satellite communication

Telemedicine Summary

- Key questions:
  - Communication
  - Off the shelf applications?

Upcoming Health Topics

- Medical Records
- Support for health care delivery
- Data Collection

Network connectivity (again)

- High bandwidth, synchronous
- Low bandwidth, synchronous
- High bandwidth, asynchronous
- Low bandwidth, asynchronous

WiFi-based Long Distance Networks

- Goal: inexpensive, high bandwidth connection
- Off the shelf, 802.11 b
- Directional Antennas
  - Modification of MAC layer protocol
- Example projects
  - Digital Gangetic Plains, IIT Kanpur
  - Aravind Eye Hospital, TIER Group, Berkeley
Why 802.11?

- Commodity hardware
  - Inexpensive broadcast
- Wimax / Cellular
  - Expensive infrastructure amortized over large user base
- Unlicensed spectrum

Line of Sight

- Range of 10s of KM
  - Longest range ~ 300 KM
- Towers are a big issue
  - Use existing buildings
  - Avoid trees!

<table>
<thead>
<tr>
<th>Height (M)</th>
<th>Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>15</td>
<td>150</td>
</tr>
<tr>
<td>21</td>
<td>800</td>
</tr>
<tr>
<td>24</td>
<td>950</td>
</tr>
<tr>
<td>27</td>
<td>1100</td>
</tr>
<tr>
<td>30</td>
<td>1850</td>
</tr>
<tr>
<td>35</td>
<td>5000</td>
</tr>
</tbody>
</table>

Costs from IITK, Height in Meters, Cost in USD

Technical Issues

- Directional antennas
- Modify to support long distance
  - Change acknowledgement protocol
- Error detection / correction important issues
- Interference
  - Does not work well around other access points

Deployment Issues

- Maintaining antennas and relays
  - Antenna configuration
  - Remote equipment
- Development challenges while hacking commodity hardware
- Relying on the network while debugging the network
  - Back channels and recovery mechanisms

Overall evaluation

- Aravind project demonstrates sustained bandwidth
- Utility in a production environment
- Cost effective
  - because alternatives are $$$
- Link throughput 5-7Mbps at 2% loss
  - 256 kbps (each way) for video conferencing
- Other deployments 500 kbps because of lack of clear line of sight

Discussion

- What role do you expect long distance wireless to play in this field?
Next Week

• Umar Saif
  – Rural Networking

• SMS Based Applications
  – Warana Unwired

• Homework Assignment
  – Design Exploration: SMS-based application