

## Computing and the Developing World

CSEP 590B, Spring 2008  
Lecture 3 - Telemedicine  
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## 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.

LUMS  
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## Technology Case Studies

## Sneaker Net

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

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## 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.

Other problems

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## 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!

Height	10	15	21	24	27	30	35
Cost	100	150	800	950	1100	1850	5000

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

