Computing for Development
A New High-Impact Research Area

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Sustainable Development

- Sustainable Development Theories:
  - Jeffrey Sachs: End of Poverty
  - Bill Easterly: Elusive Quest for Growth
  - C.K. Prahlad: Fortune at the Bottom of the Pyramid
  - Amartya Sen: Development as Freedom
  - Paul Collier: The Bottom Billion

- Commonality: “Rural Empowerment critical to sustainable development”

“Appropriate Technology a potential enabling factor to empower rural markets”
The Untapped Rural Market

- Dharavi: Largest Slum in India
  - High cost of being Poor!
  - 85% have a TV
  - 50% have a pressure cooker
  - 21% have a telephone
  - ... but can’t afford a house

- In Bangladesh:
  - Poorest devote 7 percent income to communications (GrameenPhone)

- These are valid markets...
Enabling Rural Markets

- The Cellular Revolution
  - 70% own a phone/SIM in Africa

- Mpesa, Gcash – Mobile Microfinance
  - 1 million transaction/days in Kenya

- Aravind Telemedicine Network
  - Telemedicine services for 500,000 patients/year

- Digital Green + Digital Study Hall
  - Teaching Farmers and Students using Recorded Video

- eSoko
  - A popular mobile marketplace
Aravind Telemedicine Network
Key Impact Domains

- Communications
- Healthcare
- Finance
- Education
- Agriculture
- Supply Chain + Commerce
Computing for Development

- Focus: Design, implementation and evaluation of new computing innovations that enable global social and economic development
- First world technology - a bad fit!
- Hardest Challenge: Identifying the “right problem”
- Key requirements for technology adoption
  - Locally appropriate
  - Cost-effective
  - Easy to use
  - Extremely robust
The Hard Real Challenges!

- Need for Cost-effective solutions
  - Minimalistic Computing: Design with minimal resources
- Low-cost high-bandwidth connectivity
- Appropriate Design + Accessible Technologies
- Reliability + Sustainable Power
- The Language Barrier
- And many more....

Challenges encompass several areas of CS
Sample Grand Challenges

- Getting connectivity to the next 5 billion
- Enabling easy information access in any language
- Making power ubiquitous, reliable and sustainable
- A sustainable and scalable model for development
Building Real Networked
WiFi-based Long Distance Networks
WiFi-based Long Distance Networks
WiFi-based Long Distance Networks

- **WiLD** links use *standard 802.11* radios
- Longer range up to **150km**
  - Directional antennas (24dBi)
  - Line of Sight (LOS)
- Why choose **WiFi**:
  - Low cost of $500/node
    - Volume manufacturing
  - No spectrum costs
  - Customizable using open-source drivers
  - Good datarates
    - 11Mbps (11b), 54Mbps (11g)
WiRE Architecture
Poor Quality Power
Poor Quality Power

Number of Instances seen over 6 weeks

Voltage Range

- 500 to 1000
- 400 to 500
- 300 to 400
- -300 to -400
- -400 to -500
- -500 to -1000

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Poor Quality Power

Spikes and Swells:
• Lost 50 power adapters
• Burned 30 PoE ports

Number of Instances seen over 6 weeks
Poor Quality Power

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Low Voltages:
- Incomplete boots
- HW watchdog fails

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Poor Quality Power

Spikes and Swells:
• Lost 50 power adapters
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Low Voltages:
• Incomplete boots
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Frequent Fluctuations:
• CF corruptions
• Battery Damage

Voltage Range

Number of Instances seen over 6 weeks
Reliable Solar Power

Installations in Ethiopia

Low-cost Solar Power controller

Solar panel monitoring system
TCP Breakdown Problem!
An Intermittent Usable Web

- Locally Interactive
  - Local Search + Large Semantic Web Caches

- Works over low bandwidth
  - No TCP breakdown

- Intermittency aware Web search and browsing
  - Keep the user in the design loop
## SMS-based Mobile Stack

<table>
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<th>Search service (SMSFind)</th>
<th>Drug Tracking (Epothecary)</th>
<th>Medical Records (ELMR)</th>
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<td>SMS AppStore</td>
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<td>Structured Records</td>
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<td>Compression + Reliability layer</td>
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<tr>
<td>SMS channel</td>
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PaperSpeckle

USB microscope

Paper

Microscope attached cell phone

Speckle image

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