

Computing for Development

A New High-Impact Research Area

Beki Grinter (Georgia Tech)
Tapan Parikh (UC Berkeley)
Lakshminarayanan Subramanian (NYU)



Sustainable Development

- Sustainable Development Theories:
 - Jeffrey Sachs: End of Poverty
 - Bill Easterly: Elusive Quest for Growth
 - C.K. Prahalad: 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

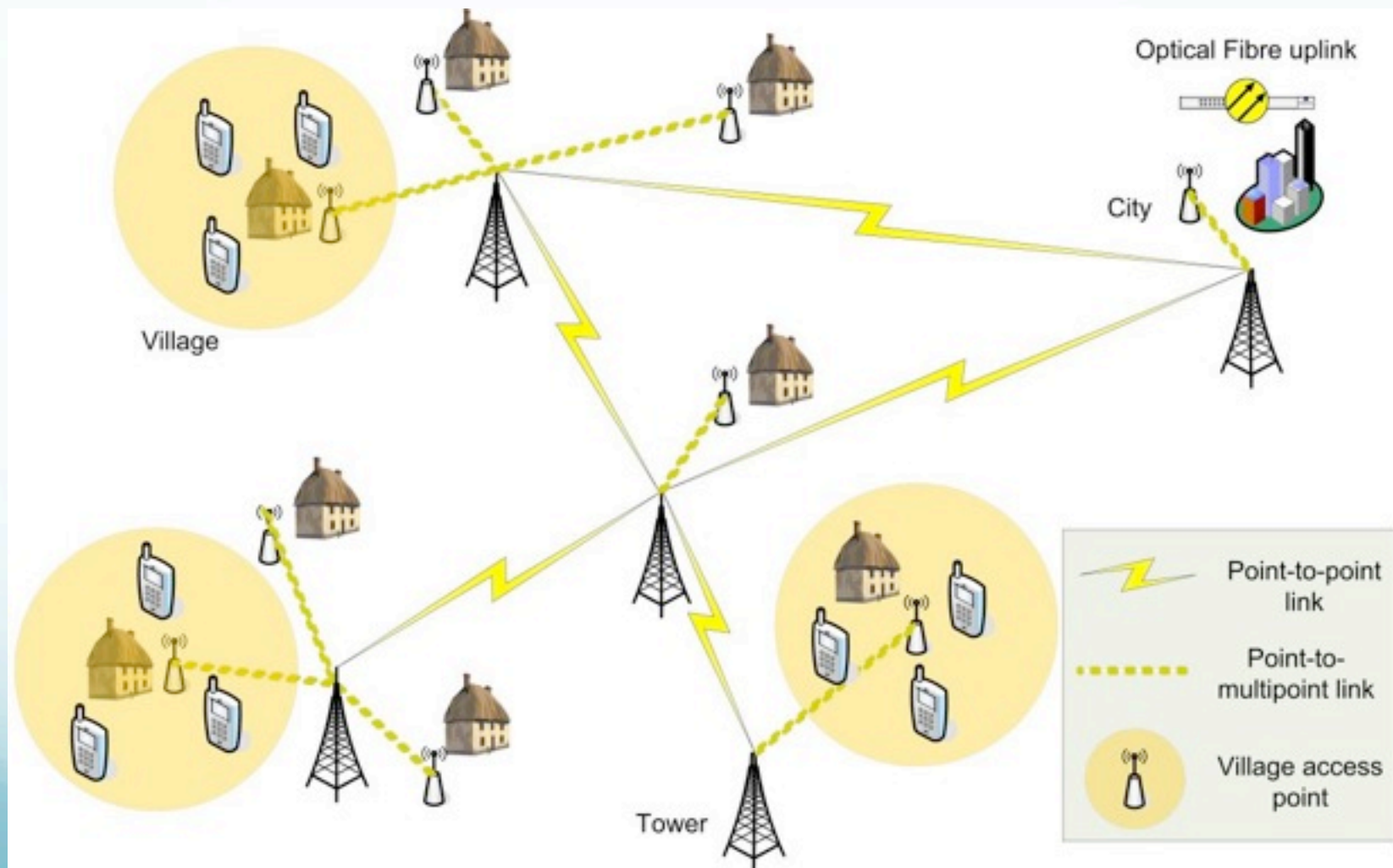
WiFi-based Long Distance Networks

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)

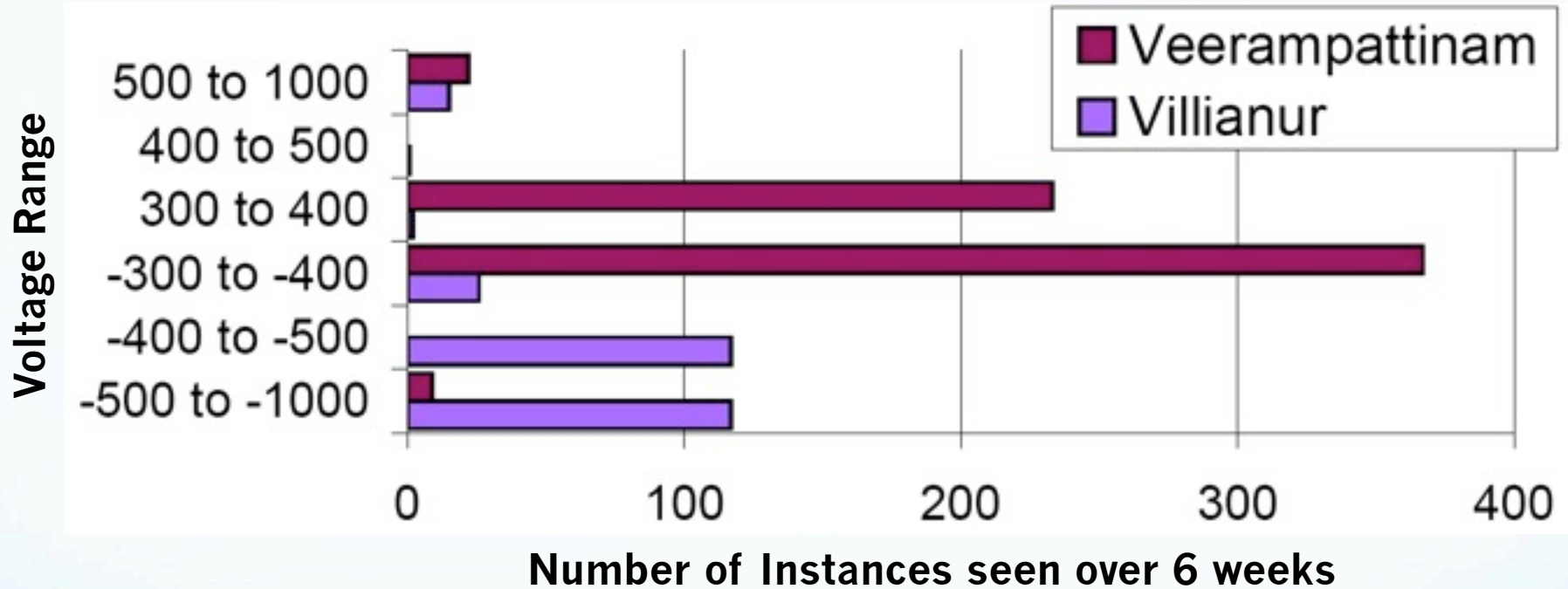


WiRE Architecture

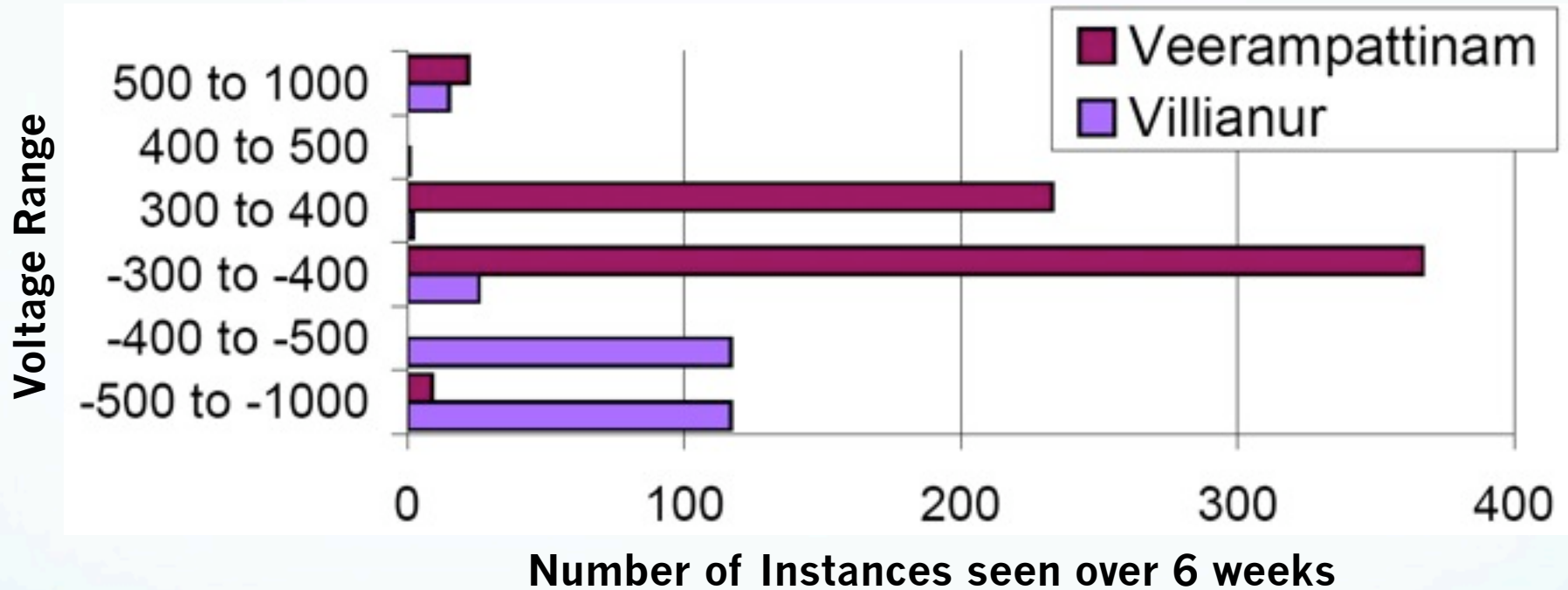


Poor Quality Power

Poor Quality Power



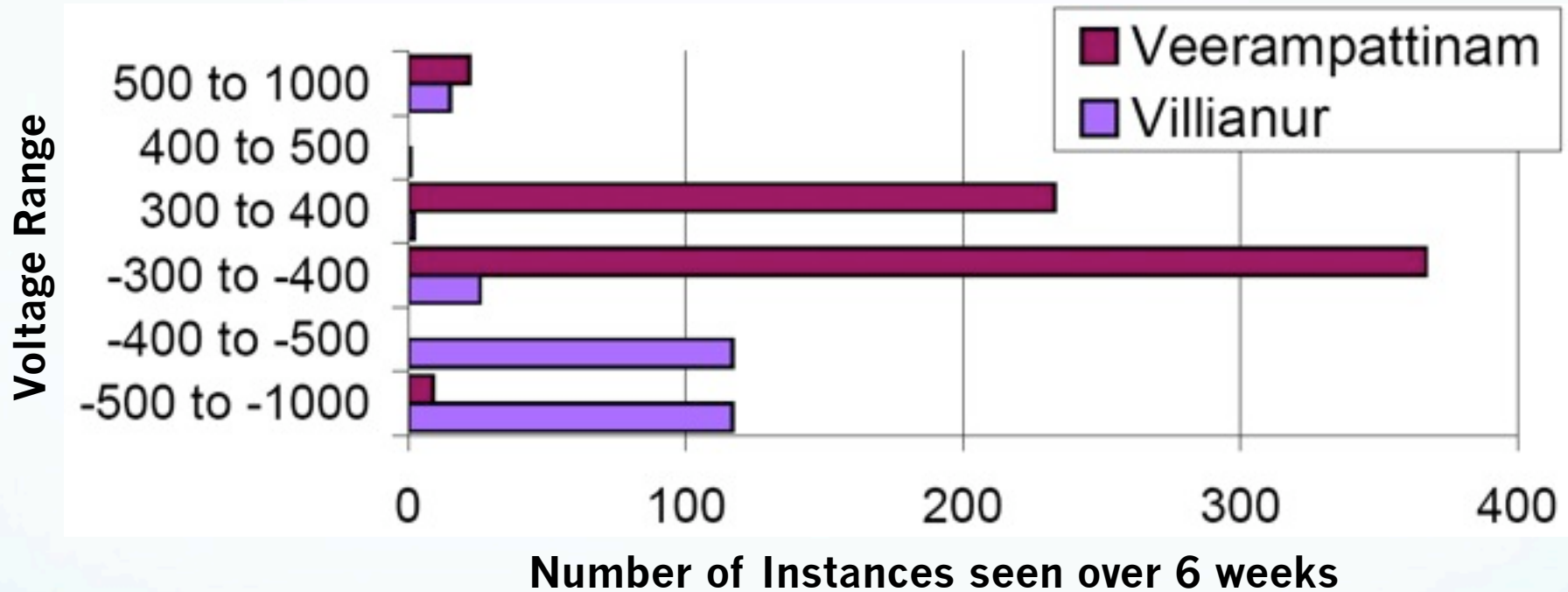
Poor Quality Power



Spikes and Swells:

- Lost 50 power adapters
- Burned 30 PoE ports

Poor Quality Power



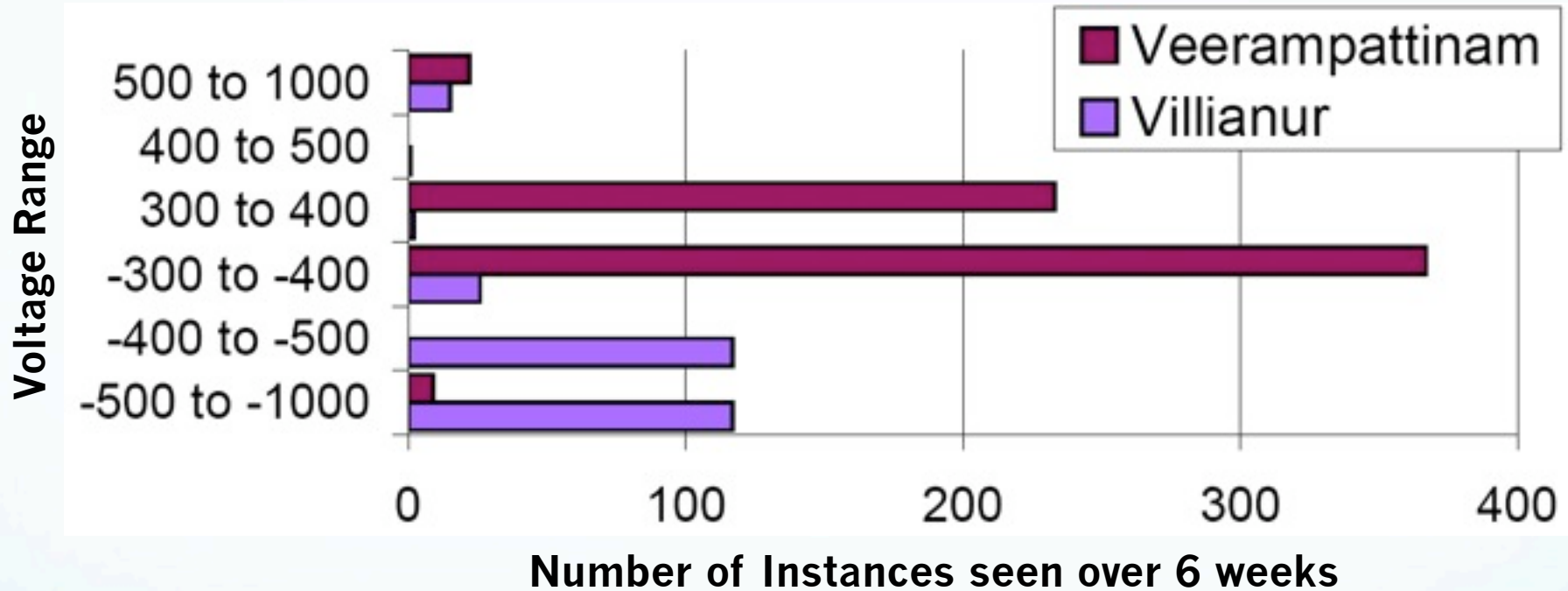
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Low Voltages:

- Incomplete boots
- HW watchdog fails

Poor Quality Power



Spikes and Swells:

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Frequent Fluctuations:

- CF corruptions
- Battery Damage

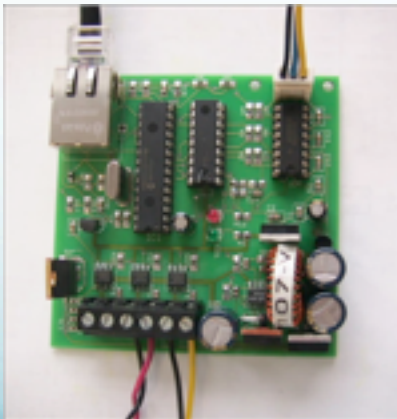
Reliable Solar Power



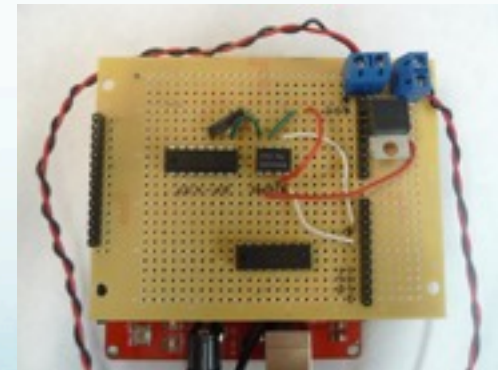
Installations in Ethiopia



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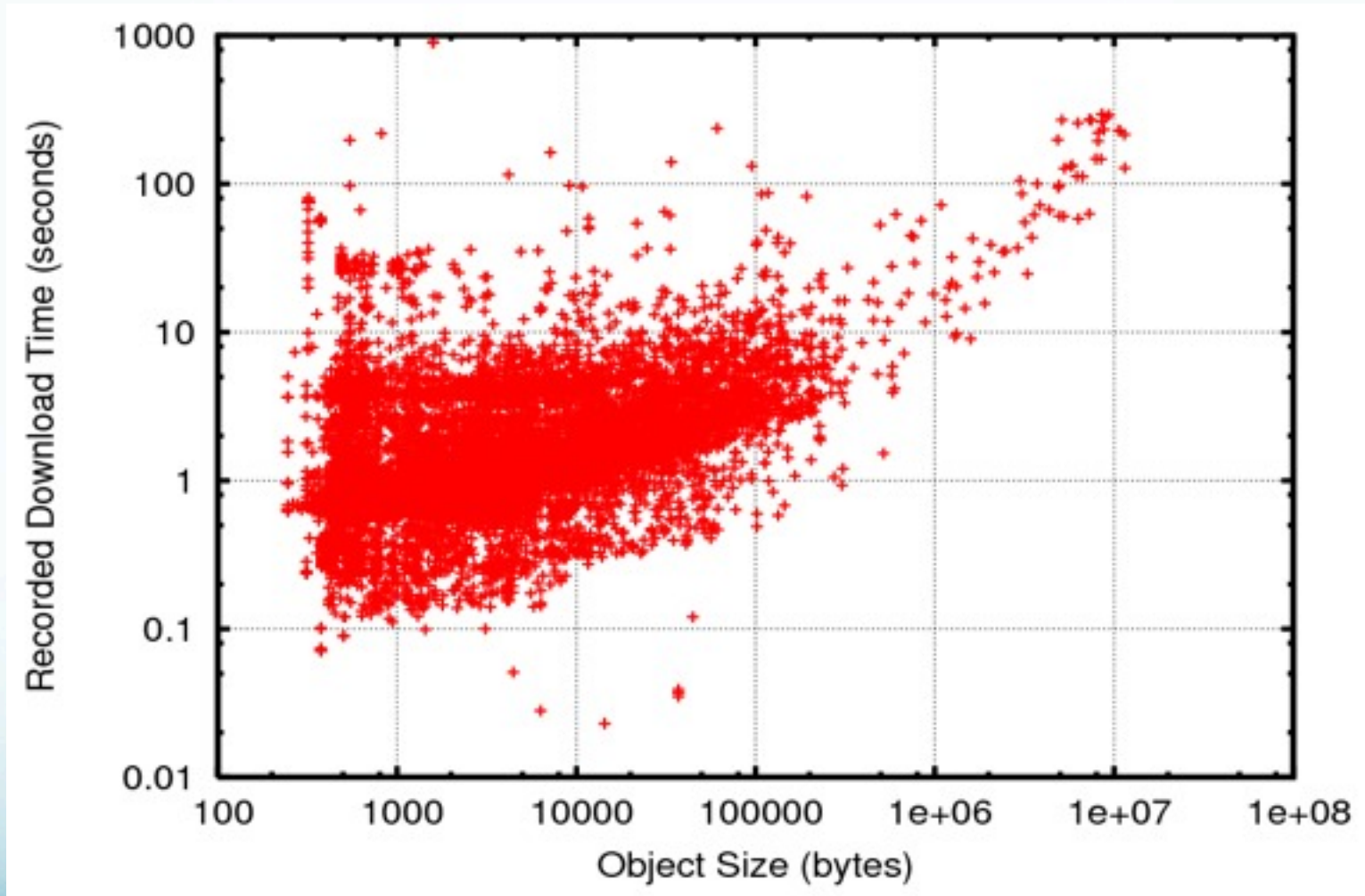
Low-cost Solar Power controller



Solar panel monitoring system



TCP Breakdown Problem!

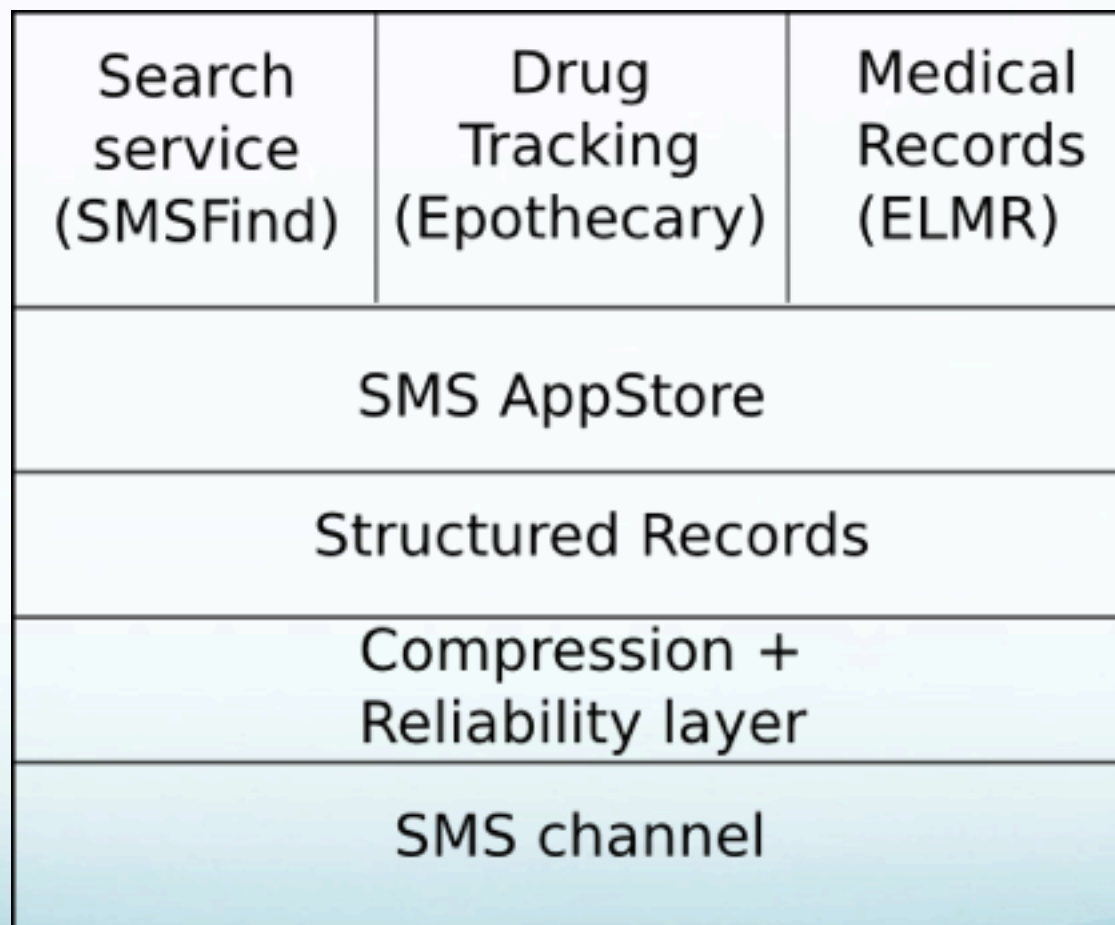


An Intermittent Usable Web

- 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



PaperSpeckle



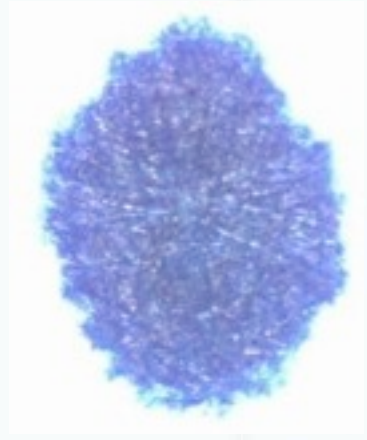
Paper



USB microscope



Microscope attached cell phone



Speckle image