

Rural Computing in India: The CITRIS TIER Project



Faculty Summit India Day

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Why ICT for Developing Regions Now?

- u Cumulative price-performance advances in technologies are bringing ICT within reach of the global poor
- u Emergence of successful business models has spurred commercial interest in these unconventional but large markets
- u Many successful pilot applications have demonstrated the positive impact of ICT on global sustainability and quality-of-life
- u And many of the very best ICT researchers from throughout the world are passionate about this challenge!

BREWER'S CONJECTURE:

Providing traditional enabling infrastructure, like building out roads, rail, the electrical grid and providing piped water is very expensive and can only really be economically justified for high density, relatively affluent communities.

Network infrastructure, on the other hand, is inexpensive enough to deploy economically to rural areas and can be used to build the economic base that then justifies investing in roads, rail, electricity and water grids later.

Source: Eric Brewer





Open, Standards-Based Global ICT Platform: Infrastructure and Basic Services

- ⌋ Very Low Cost, Operates Off the Power Grid, Designed for Intermittent Connectivity, Supports Low Literacy and Multiple Languages, Reliable in Extreme Environments, Supports Shared Access, Private and Secure
- ⌋ Must support telephony (synchronous and asynchronous) & data communication
- ⌋ Must support sensor networks (potentially millions of sensors/application)

Network access feels just like
power grid access in a developed community:
You simply "plug in" (wirelessly, of course!)

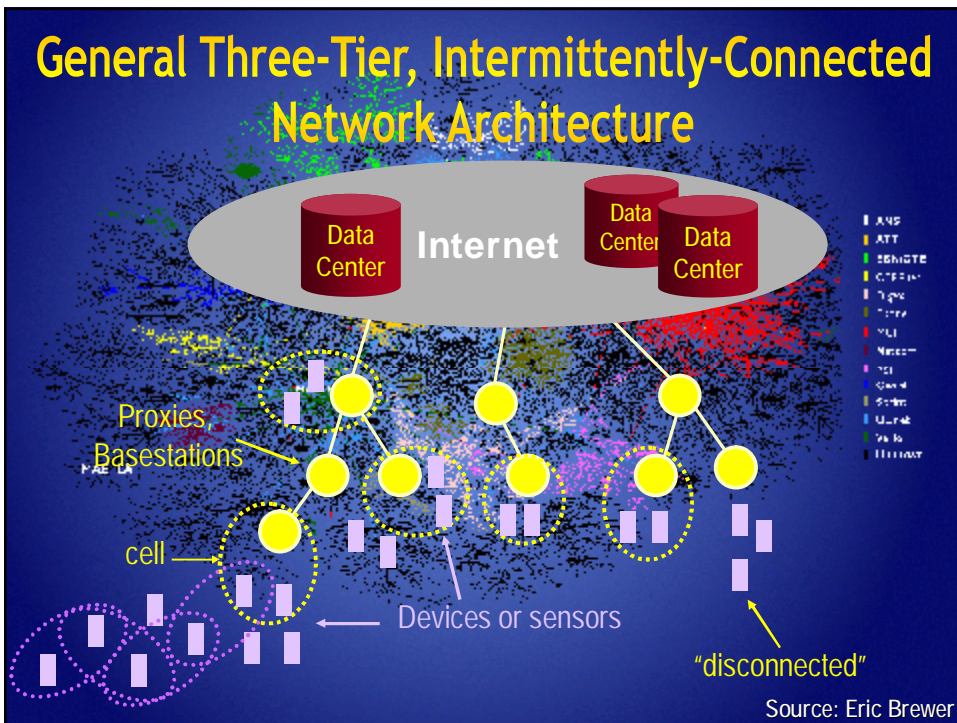
"People Are the Killer App of the Internet"

Pavel Curtis, Xerox PARC, 1992



- ⌋ Online Auctions
- ⌋ Mega-Player Online Games
- ⌋ Simple Telecommunications
- ⌋ Education & Training
- ⌋ Blogs, Friendster, Livejournal, Tribe.net
- ⌋ Time-Sensitive "Valuable" Data
- ⌋ SMS to MMS++ to Multimedia Calls
- ⌋ Distributed Collaborative Environments
- ⌋ Business Relationships & Negotiation

The power of ideas and opportunities, fueled by local entrepreneurial energy, is the most powerful resource available in this resource-scarce part of our world.



A Village Basestation: 2004

Support 100 simultaneous feeds at > 1Mbps each



- u 100M logic gate equivalent
- u 1 Gbyte Memory
- u 200 Gbytes Disk
- u Battery
- u Silicon Solar Cells (1.5m²)
- u Mechanical Structure

- u Cost US \$750
- u Dissipate 250W at full load

A Village Basestation: 2010

Support 200 simultaneous feeds at > 2Mbps each



- u 300M logic gate equivalent
- u 10 Gbyte Memory
- u 10,000 Gbytes Disk
- u Battery
- u Silicon Solar Cells (1m²)
- u Mechanical Structure

- u Cost US \$500
- u Dissipate 150W at full load



Devices

- u Develop standard chip family for human application P \$1-7 per chip
 - v Processor, memory, radio; network, speech, and display support
- u Develop standard chip family for sensor application P \$1-0.01 per chip
 - v Processor, radio, power management, network support, integrated GPS option
 - v Low-power version < 200 microwatts
- u Novel low-cost organic semiconductors for flexible displays and inexpensive circuits
 - v 10-50x cheaper, ultimately more robust

Asynchronous Two-Way Communication

- u The telephone system was developed when memory and storage was expensive
- u Semi-interactive, but potentially much less expensive...
- u Savings:
 - v No need for dedicated resources
 - v Can "store-and-forward" data (like real mail)
 - v Can hide problems (e.g. power out) by waiting or redundancy
- u Examples: voice messaging, SMS/MMS, correspondence classes, medical diagnosis (non-emergency), coordinating money transfers, e-commerce (e.g. catalogs), e-mail

Light-Weight Audio SMS



The Technology Peace Corps Prototype

- u Idea co-developed by Tom Kalil, Rich Newton (Berkeley) & Raj Reddy, Bernadine Diaz (CMU)
- u Berkeley prototype evolved from Bridging the Divide 2004, led by Drew Isaacs (MOT)
- u 8 teams of 4 students, from Engineering, Haas, SIMS, Economics, Public Health, ERG, City & Regional Planning, ...
- u Semester studying how to test a hypothesis, conduct interviews, behave in a foreign culture, etc.
- u 1-2 months away over summer; many return trips planned in the fall



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Project Name	Country	Researchers	Schools	Field Work	Faculty Advisor
1. <u>Extending the uses of Microfinance in a Newly Deregulated, Developing Economy</u>	Uganda	Matthew Kam Jessica Lubio Chris Rider Tu Tian	Computer Science Economics IHaas SIMS	August	David Levine, Haas
3. <u>Cervical Cancer Prevention through Safer Technology</u>	South Africa	Doris Chenu Jan Chetani Meri Gavanika Rashed Young	Public Health IHaas	August	Paul Gertler, Haas
4. <u>Extending the Available Model of Low-cost Medical Care and Technology to new Markets</u>	India	Anan, Shandari Mahad Ibrahim Sam Koeniger Jaspal Sandhu	Public Health SIMS IHaas Engineering	June/July	Sandra Dyalal, Haas and SIPH Anandee Saxena, SIMS
6. <u>Coproduction of Electricity using Clean Business Composites in Rural India</u>	India	Darbana Haya Sujit Kripakar Malini Rangarathan	Energy and Resources Engineering	June	Alex Ferrell, Energy and Resources Group
6. <u>Development of Industrial Clusters in China's Electronics Industry</u>	China	Xiaodong Jiang Lynn Lee Chenwei Shen Suah Wang	Engineering Chemistry Haas	August	Anni aa Saxena, SIMS
7. <u>Solar Power and LED Systems for Rural Lighting</u>	China	Ilan Gur Rebecca Jones Zachary Gentry Tom Du	Engineering Haas	August	Richard Newton, Engineering

What have the TIER TPC Researchers Accomplished this Summer?

- u We are working with M. S. Swaminathan Research Foundation (MSSRF), Aravind Eye Hospital, and the Akshaya (e-gov) project in Kerala
- u This summer, we got towers up and set up two links: one from Aravind to one of the MSSRF villages (only 3km) and a 10km link that reconnects that village with the hub
 - v It had a connection that was broken, but we reused the towers and antennas
- u We showed videoconferencing between the hospital and the villages (sufficient for basic telemedicine)
- u We collected 30 samples of Tamil speech for our speech recognizer
- u We set up and left a proxy cache that sits in front of the VSAT (which is the only connection from the villages to the outside Internet)





Principal Conjectures

There are a million useful things we could work on, but:

- u A very low cost and reliable network infrastructure, available to everyone, that supports communication and data, is absolutely necessary (but not sufficient...) if we are to support sustainable economic development in poor, rural areas.
- u The most important application to support is communication—'people are the killer app'—but most likely in a very different modality than what we use here in the developed world today
- u The problem is not simply a technology problem ('just put up wireless links')—it is as much a systems architectural problem (e.g. where do you put data storage and why?)

Principal Conjectures

- u Like the introduction of the railway system in the US, the introduction of an open, standards-based national and international communication backbone network will enable or enhance many small businesses—many of which we cannot imagine today
- u A sustainable business model for deployment and use is critical to success and must be designed in conjunction with the technology—ideally, the system will be deployable in a locally-owned, 'viral' way, based on a reference architecture and a pay-as-you-use-it service model

ICT for Sustainable Development: Next Steps

Working together, we must establish:

- u An active, global research and development community of interested university, industry, NGO, and government participants
- u A premier international conference with the highest of academic standards—A World Technology Forum
- u An international business plan competition for both developed and developing countries targeted to the developing world
- u Develop a research and development roadmap for sustainable development
- u A world-class publication accessible inexpensively throughout the world
- u An international Engineering “Peace Corps” for students and young professionals to work together to address problems and to learn about the challenges and opportunities in the developing world

Source: Tom Kalil, Richard Newton