# Mobile and Ubiquitous Computing

## Mobile Computing for Development

Veljko Pejovic

# Outline

- What is ICT for development and why do we need it?

- Applications of mobile for development

- Challenges in designing technologies for development

- Example studies: rural area network analysis and mobile service extension

# ICT for Development

- Example: A mobile phone app that helps unemployed people in poor areas of Johannesburg, South Africa find jobs.
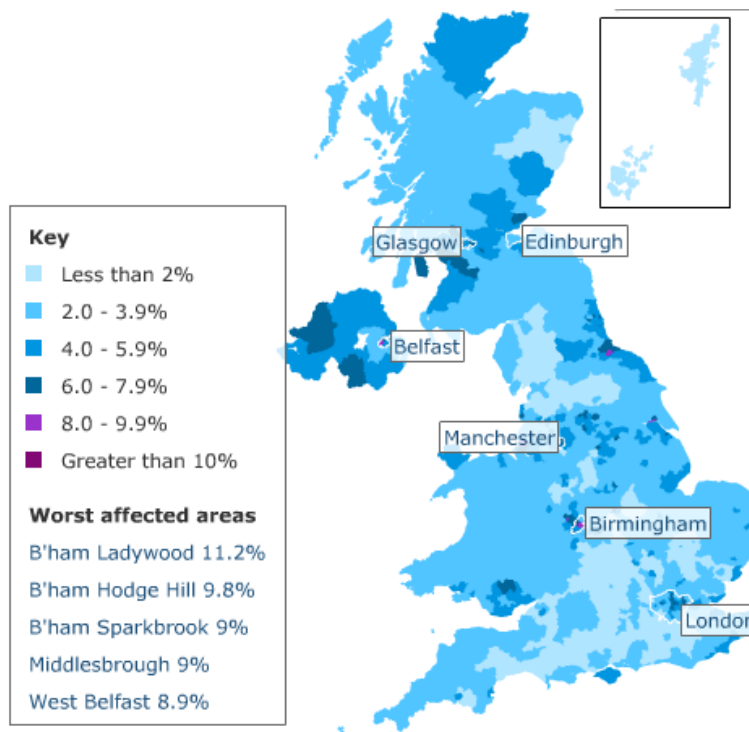


Truly ICT for development, right?

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# ICT for Development

- Example: A mobile phone app that helps unemployed people in poor areas of Johannesburg, South Africa find jobs.



What about the same app in poor areas of Birmingham?

# ICT for Development

- My view: every ICT intervention that leads to positive societal change is ICT for development.

- Still, we have to concentrate on what we call "the developing world", as people there have unequal opportunities to advance.

- In addition, the lack of alternative ways of communication, trading, health care means that ICTs can have a huge transformative impact.

- Example of strong modern ICT impact: many developing countries completely skipped the fixed telephone line step, and directly evolved to mobile communication networks.
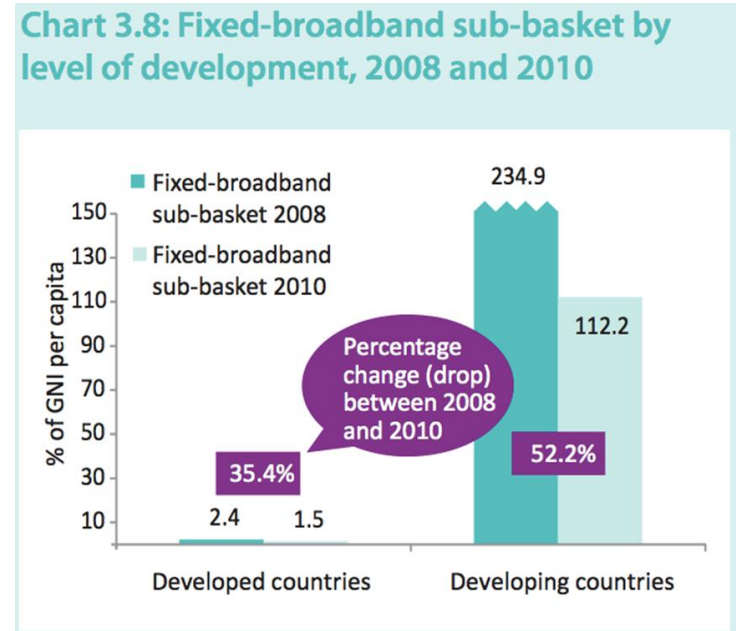
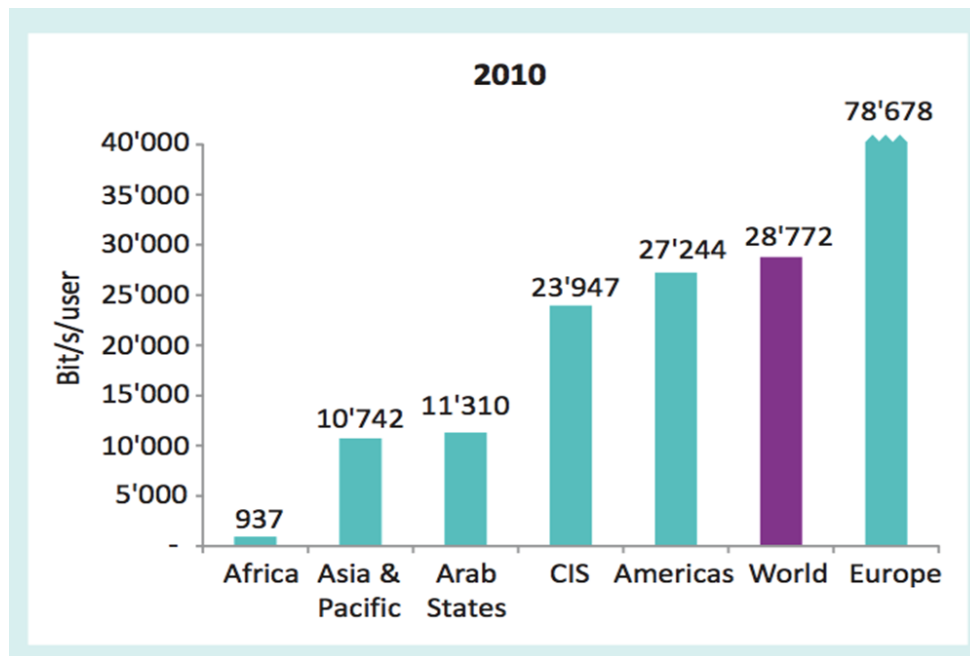# ICT for Development

- **Digital divide** – a gap between those who do and those who don't have access and ability to use modern ICTs.



**Internet users per 100 inhabitants**
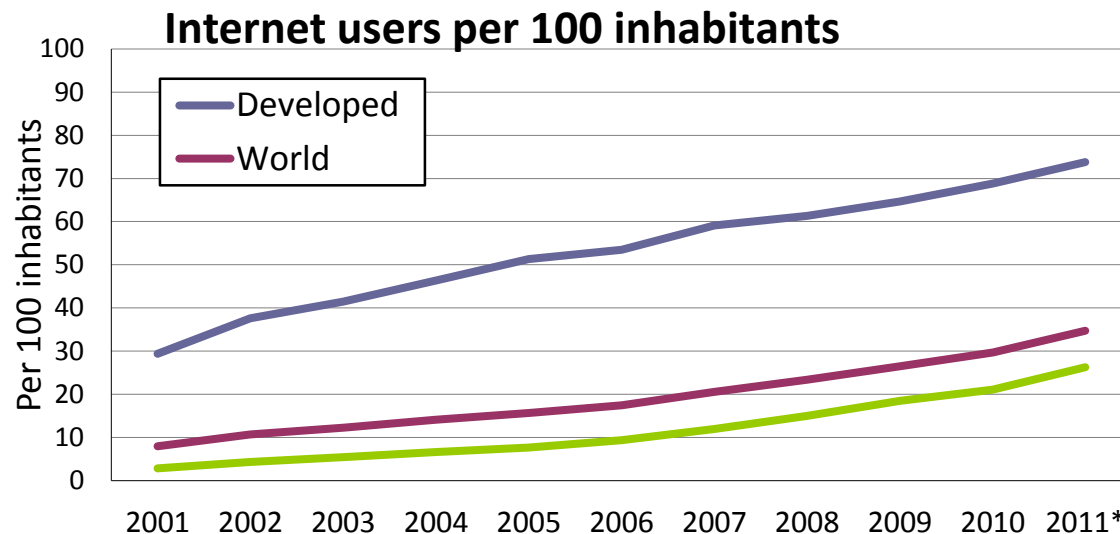
# ICT for Development

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# What can ICTs improve?

# ICT for Economy

- With mobile phones fishermen know the exact demand and supply and can adjust prices on-the-fly.

- Information about crop rotations, good farming practices improves crop yield.

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# ICT for Economy

- Money transfer:
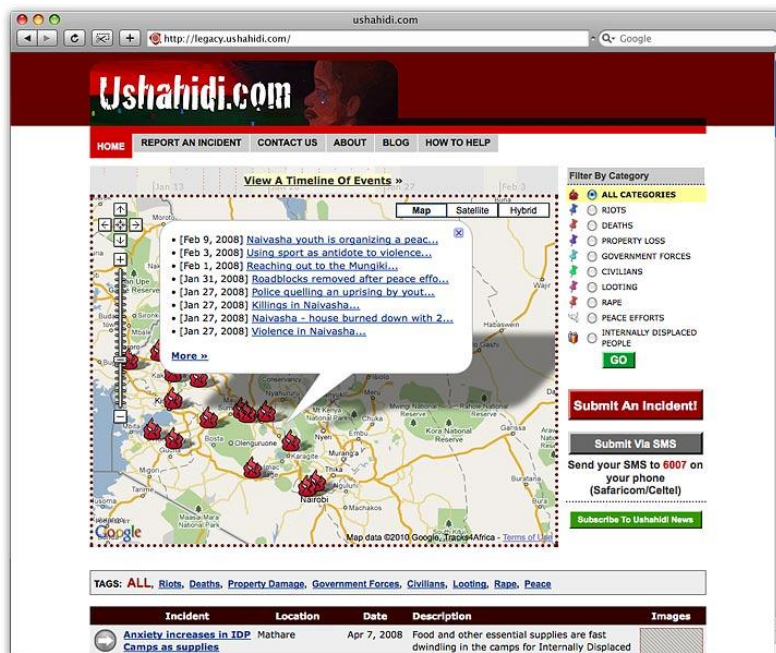  - M-Pesa:
    - Mobile payment system used extensively in Kenya
    - Load your SIM card with monetary funds and send an SMS when you want to pay for goods, services or transfer money to someone

# ICT for Democracy

- Monitoring elections
  - Ushahidi: collect reports of violence via SMS or email.
- Organizing demonstrations
  - Online social networks played a big role in the Arab spring.

# ICT for Health Care

- Safety monitoring milk pasteurization
  - 40% of HIV+ babies in Sub-Saharan Africa get infected by breastfeeding from HIV+ mothers. Phone app administers Flash-Heat Pasteurization that deactivates HIV.

# ICT for Health Care

- Vaccine cold chain monitoring
  - Vaccines need to be transported in $2^o$ to $8^o$ C temperature range.
  - A phone installed on a vaccine fridge sends its current location (cell ID) together with the temperature reading from the sensing board.
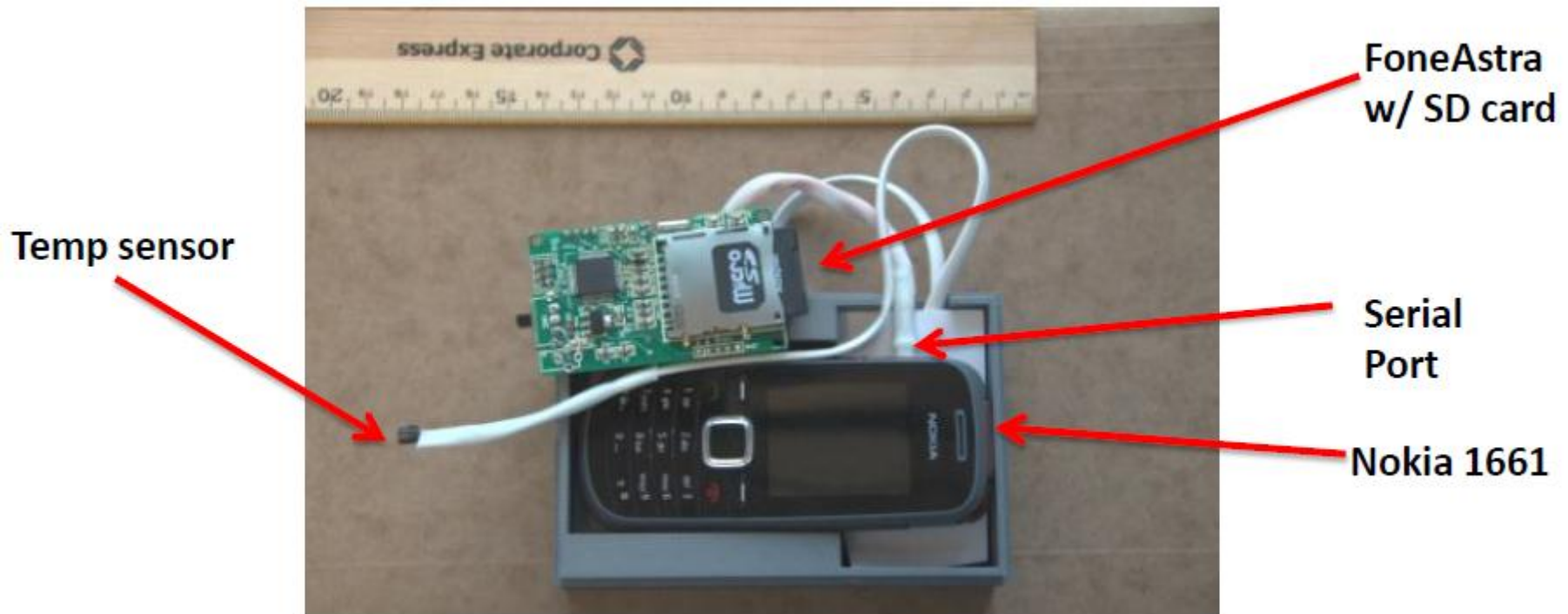
# ICT for Education

- One laptop per child (OLPC)



- Dr Math via Mxit
  - Mxit - Free Instant Messaging application for even low-end phones.
  - Dr Math – connect kids in rural areas with math tutors.

# ICT for… whatever users want

- Investigation of mobile phone usage in a slum in Hyderabad, India reveals that youth uses phones for entertainment (how surprising!)



- Jamaicans developed a strong network of social relationships that relies on mobile phones: call relatives abroad, ask for money, arrange for children to be raised by cousins.

# Recap of ICTs for development

- Technology can catalyse positive societal change: economy, education, political freedoms, health care can all be improved through technology

- Technology should not be the end goal, and often it is hard to predict what will happen. Especially if those who develop technologies are not familiar with their users.

- Some indications show that more than half of ICT for development projects fail in their first year.

- Some thrive in certain environments, but not elsewhere.

M-Pesa is huge in Kenya (about a third of the Kenyan GDP passes through it), but it never took off in India. Why?

# Challenges in Designing ICTs for Development
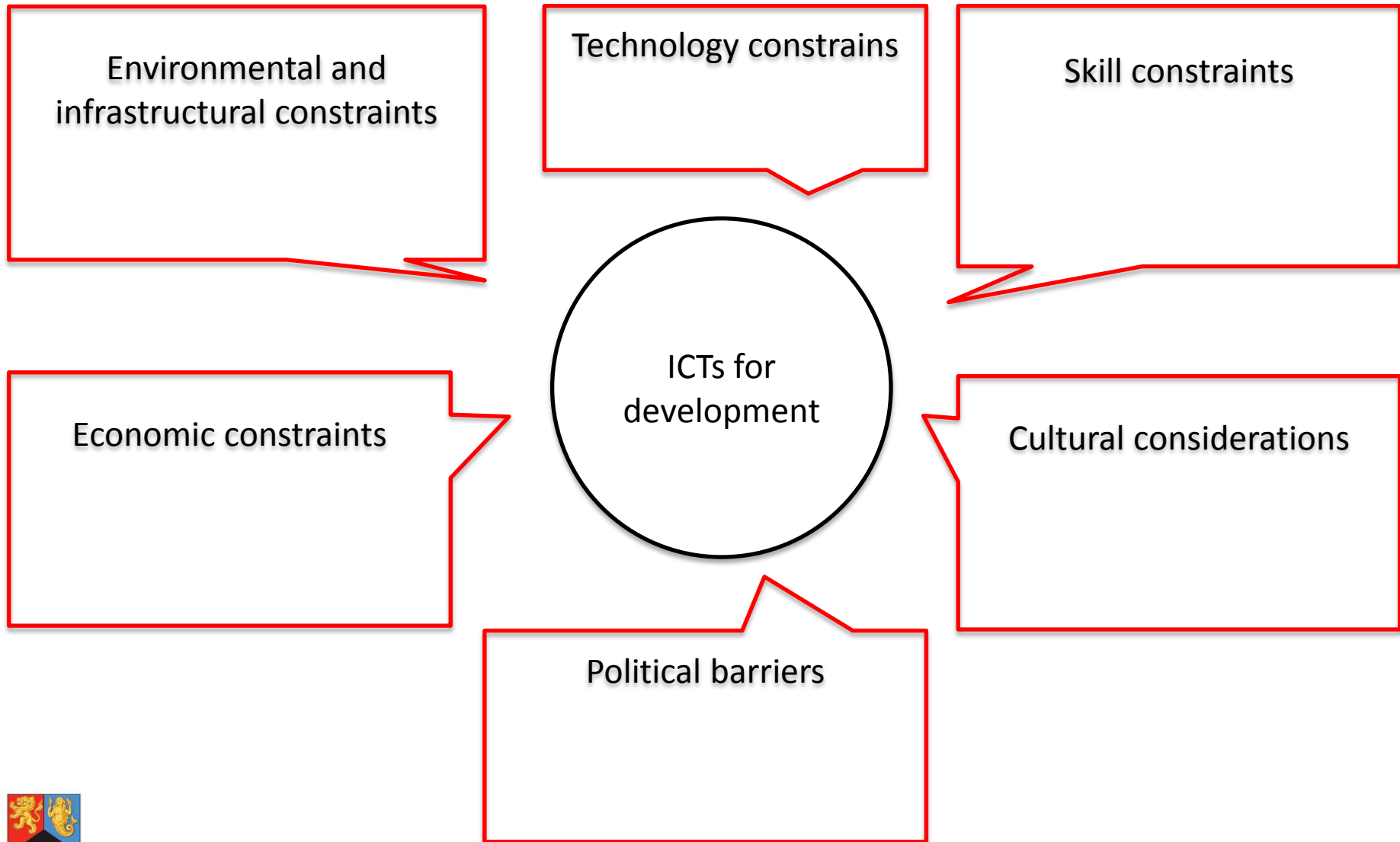
Environmental and infrastructural constraints

Technology constrains

Skill constraints

ICTs for development

Economic constraints

Cultural considerations

Political barriers

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# Examples of a constraints

Environmental and infrastructural constraints

ICTs for development

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# Examples of a constraints

Environmental and infrastructural constraints

ICTs for development

- Lack of electricity – in rural Sub-Saharan Africa only 14% of the population has access to electricity
- Equipment designed for western world offices is inappropriate for dusty outdoor environments
- Roads are bad or non-existent

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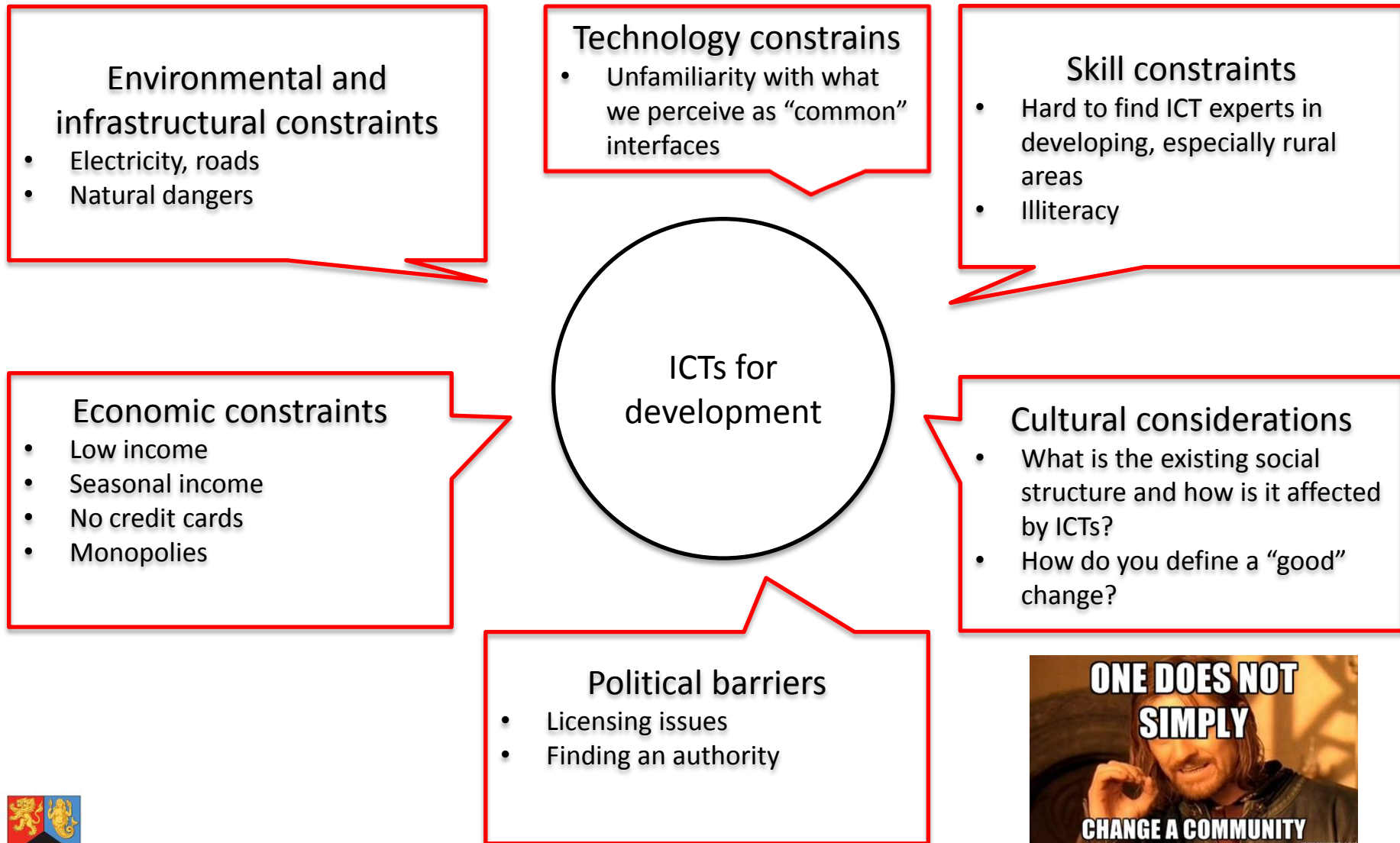# Examples of a constraints

Environmental and infrastructural constraints

ICTs for development

Why don't we use solar panels?

# Challenges in Designing ICTs for Development

**Environmental and infrastructural constraints**
- Electricity, roads
- Natural dangers

**Technology constrains**
- Unfamiliarity with what we perceive as "common" interfaces

**Skill constraints**
- Hard to find ICT experts in developing, especially rural areas
- Illiteracy

**Economic constraints**
- Low income
- Seasonal income
- No credit cards
- Monopolies

ICTs for development

**Cultural considerations**
- What is the existing social structure and how is it affected by ICTs?
- How do you define a "good" change?

**Political barriers**
- Licensing issues
- Finding an authority

ONE DOES NOT SIMPLY CHANGE A COMMUNITY

# Design ICTs for Development

- Observe and learn
  - Without knowing the true needs of those whom you want to help, you are likely to only cause harm.

- Partner up with key local stakeholders
  - Societies can be complex, with social systems you are not familiar with. A chief might have more power than an elected politician. Religion may be important, and church gatherings may help you understand how communities live.

- Iterative development with direct local feedback
  - Designing technologies under constraints is hard, almost impossible to be successful straight away.
  - Solutions are designed to be used, listen to your users and modify on the spot.

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# Case study: rural area network analysis

- Understand how people in rural Africa use ICTs
  - Macha, Zambia and Dwesa, South Africa two deep rural villages with local wireless networks
  - We established strong links with both villages: one of the study authors spent ten years in Macha

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- Monitor network traffic and conduct interviews
  - Internet usage
  - Legacy communication practices
  - Social aspects of computer networking
  - Quality of service issues

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- Monitor network traffic and conduct interviews
  - Internet usage
  - Legacy communication practices
  - Social aspects of computer networking
  - Quality of service issues
- Learn about problems and needs of local population
  - Importance of local communication
  - Location of access constraints
  - Severe network congestions

People like to talk to their neighbours
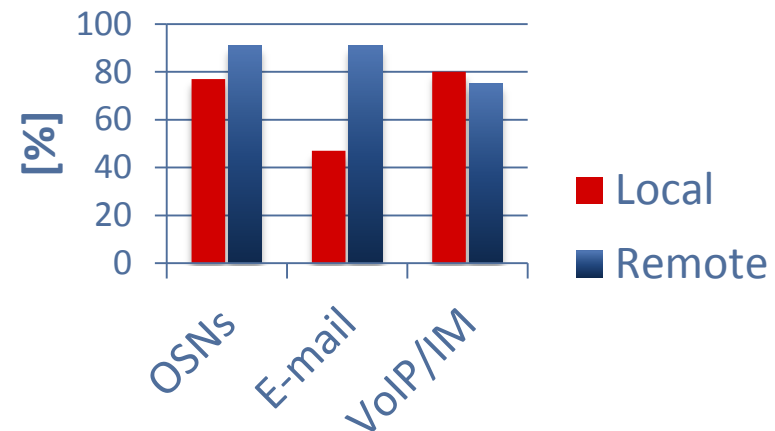


Everyone has a mobile phone, but there's no connectivity

# Case study: VillageCell – extending coverage

- Voice communication in rural developing areas is important:
  - Illiteracy prevents written forms of communication
  - Lack of road infrastructure means it's hard to travel
  - Information diffusion helps economy, health care, education
- Local voice communication via mobile
  - Everyone has a mobile, it's a cheap, robust device
  - People want to talk to their local community

> There's no coverage:
> - mobile phone base stations are expensive.
> - Rural areas are sparsely populated with people who earn little, seasonal income
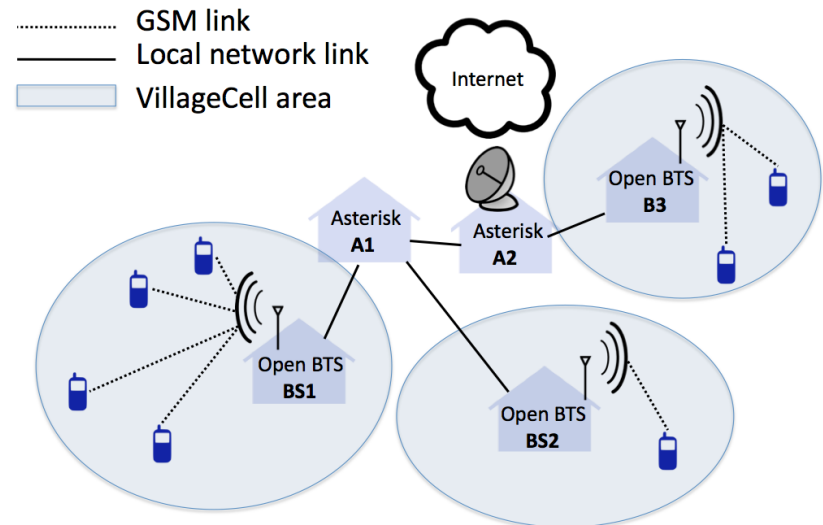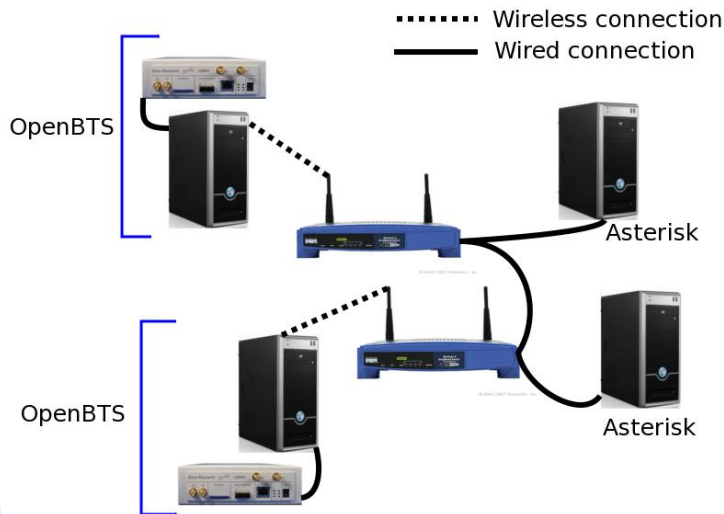> **Big telecoms don't want to invest money in rural infrastructure**

# Case study: VillageCell – extending coverage

- VillageCell:
    - Low-cost, low-power system for local GSM coverage
    - Use Software Defined Radio and OpenBTS (open source GSM)
    - Use Asterisk for call routing

Radio that transmits at a given frequency and with any protocol you can build in software on a common PC

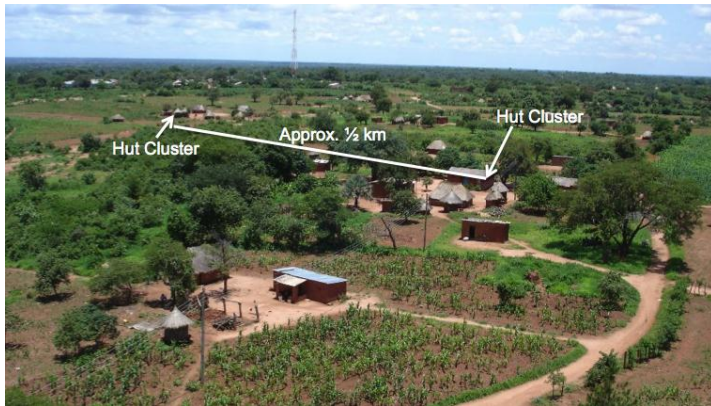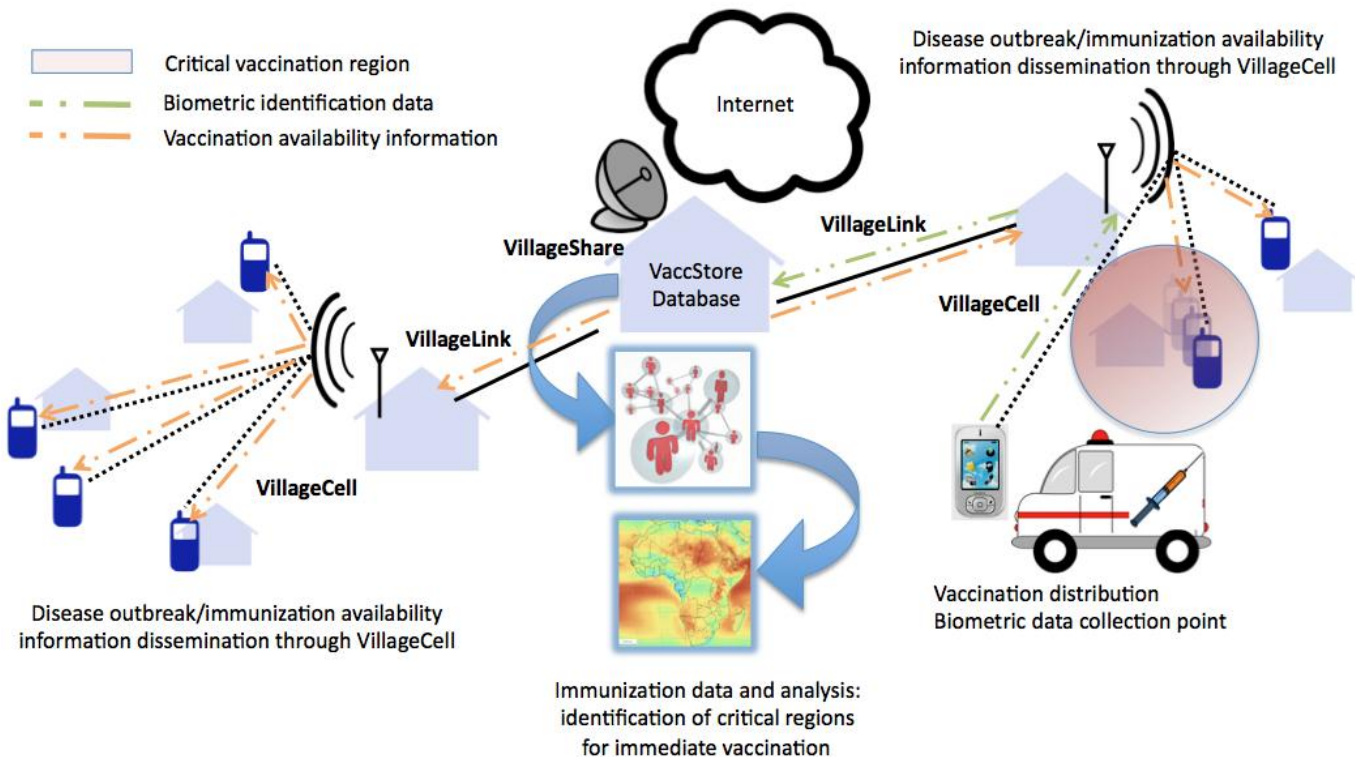# Case study: VillageCell – extending coverage

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# Case study: VillageCell – extending coverage

- Taking VillageCell further
  - Vaccination dissemination
  - Tracking who has been vaccinated



Critical vaccination region
Biometric identification data
Vaccination availability information

Disease outbreak/immunization availability information dissemination through VillageCell

Internet

VillageShare

VaccStore Database

VillageLink

VillageCell

VillageLink

VillageCell

Disease outbreak/immunization availability information dissemination through VillageCell

Vaccination distribution
Biometric data collection point

Immunization data and analysis: identification of critical regions for immediate vaccination

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# How do I get involved?

- Follow the field:
  - ICTD conference
  - ACM DEV conference
- Relevant mailing lists:
  - change@change.washington.edu
  - TIER@tier.cs.berkeley.edu
  - http://trac.tools.ietf.org/group/irtf/trac/wiki/gaia
  - http://groups.google.com/group/hci4d
- Pursue a PhD on the topic:
  - ICT4D groups from Africa (University of Cape Town) to West Coast USA (UC Berkeley, UC Santa Barbara, University of Washington)
- Get involved with engineering groups
  - Engineers without borders
  - One laptop per child project
  - ICT4D companies and organisations: Ushahidi, Frontline SMS, NSRC Oregon, A4AI, Internet Society

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- One laptop per child www.laptop.org

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**Collaborators:**

- Elizabeth Belding, University of California, Santa Barbara, USA
- David Johnson , CISR, South Africa
- Mariya Zheleva , University of California, Santa Barbara, USA
- Abhinav Anand , Qualcomm
- Gertjan van Stam, MachaWorks, Zambia
- Oscar Kaate, MachaWorks, Zambia

Veljko Pejovic

v.pejovic@cs.bham.ac.uk

www.cs.bham.ac.uk/~pejovicv

# Food for thought

- Think about a technology that can improve the quality of life in Liberia
  - 182/187 countries by human development index
  - 3% electrification rate, power plants destroyed in wars
  - Long history of political instability and civil wars
  - Widespread communicable diseases: tuberculosis, malaria
  - Imports food – vulnerable to food shortages
  - The official language is English and is widely spoken

> "…for rural users phone is a connection to the outside world; prevents sexual violence, robbery…"
> "Uses of Mobile Phones in Post-Conflict Liberia", Best et al. ICTD 2009