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Can *Low Cost Networking* provide a solution to wider ICT network access in developing countries?

Introduction

There are many successful examples of innovations with ICT in developing countries in many sectors of society (government, healthcare, logistics, trade, education, etc). These examples prove that the technology can work, that people can learn how to use it and processes can be optimized accordingly. So we appear to know *what* to do and *how* to do it successfully.

For some reason however we have failed to scale up from a proof of concept (local level) to a proof of reproduction and proof of scaling up (national level). In order to reach the Millennium Development Goals[2] it will be necessary to scale up all development initiatives to national level and beyond. Widespread ICT infrastructure at affordable cost is a major enabler in providing general information, communication, healthcare, education and government services to all.
We are used to being online most of the time, wherever we are. Thus we are able to communicate with friends, colleagues or business relations, or to access private or collective information.
There are, however, many rural areas in developing countries which are deprived of internet access. This creates a “digital divide” which should be closed as soon as possible. All our fellow world citizens should have the possibility to connect to the virtual global community.
Internet access is a most powerful means to boost development in rural areas in emerging countries. It is creating a new perspective for people living in those areas. First of all, it is providing the possibility to communicate by telephone (VoIP) and email. In addition, internet provides access to a wealth of information that is of crucial importance for healthcare, education, agriculture and economic development. ICT can create new jobs, thus reducing the need for young people to leave their village and go to cities in search of job opportunities. As we all know this search regretfully fails most often .

Low cost networking is a concept that could help to reduce the digital divide. It is a technology that provides the ability to combine available ICT resources to work together as one virtual network. In principle each resource can be owned by different parties as long as certain standards are adopted. Each addition in the infrastructure strengthens the network. This decentralized architecture also means investments can be small and gradual rather than the large upfront investments required in traditional telecommunication infrastructure deployments.

A network (although heterogeneous) that covers a complete nation has a tremendous positive effect on the economy and will also make it possible to scale up development initiatives. The flow of information and communication will make organizing things much easier and will facilitate logistics enormously.
Naturally the rules and laws of a society need to be in line with the new possibilities and risks that an infrastructure like that provides and enough people need to be

[1] http://www.tno.nl/informatie-_en_communicatietechnologie/index.xml
TNO is a W3C member
[2] *The End of Poverty, how we can make it happen in our lifetime*,
Jeffrey D. Sachs, Penguin Books 2005

trained to develop the right competences to organise, manage and maintain the infrastructure.

Successful example of innovations with ICT

Two examples that provide many useful aspect are the Grameen[3] phone and CyberNet. Grameen bank is a well known microcredit bank with more than 2.3 million borrowers. One of the programs of Grameen is to provide rural women with access to telephones in a nation where only 0.3 percent of the population has a mainline telephone (Bangladesh). Today there are over 2,200 telephone ladies employed by Grameen Telecom (a branch of Grameen Phone) in Bangladesh. And the number is growing. Grameen Telecom has set a goal of creating 40,000 village phone ladies. Microcredit borrowers can take out a loan from Grameen Bank to start a telephone business. One third of these borrowers have never used a telephone in their lives. Nevertheless, a "telephone lady" earns an average of $300 per year, slightly higher than the per capita income in Bangladesh. This example shows that microcredit and information technology are mutually reinforcing - giving dignity and self-reliance to the poor.
Another initiative of Grameen is Grameen CyberNet, the largest Internet company in Bangladesh. Through cyber kiosks, the organization is trying to bring the Internet to rural villages. Grameen Communications, which owns the entire Bangladeshi fiber optic network, intends to join with Hewlett-Packard to create an e-healthcare, e-banking and e-education system that will reach rural villages.

Low cost networking, the plan

Analyzing the cost structure of wireless infrastructure systems reveals that the cost component representing the actual electronic equipment is a rather small fraction of the total cost in current systems. Furthermore this cost component is shrinking due to the advances in microelectronics, providing more functionality at lower cost & size (“Moores Law”). The dominating cost factors (and capital expenditure) are instead related to the physical deployment of the infrastructure, such as planning, installation of antennas & towers and cabling. Also the maintenance of the infrastructure is an important factor. Whereas the traditional approach has been directed towards cheaper equipment, the focus should shift to reducing the total system cost.

Within the Ambient Networks[4] program (a program of the EU under the Information Society Technologies priority) and Affordable Wireless Services & Infrastructure[5] project in Sweden, work has been done on low cost networking by ad-hoc and automatic composition of networks while maintaining security. Composition of networks means they are able to act as one seamless network to the end user. Most of this work has been positioned in the situation of developed countries to improve quality of service, coverage and bandwidth while keeping the cost down. Other scenarios include emergency situations or large events that need network resources suddenly on a specific location.

The goal here is to provide affordable network access to more people by using technology and concepts like composition and apply them to the needs of developing countries using present day and proven resources. The paradigm of each resource adding to the network in an ad hoc and unplanned way also provides the opportunity of a business model with many small “operators” that could earn a living with relatively low investments (small enough for micro-credit?) and good opportunities for scaling up.

[3] *www.grameen.org*
[4] http://www.ambient-networks.org/
[5] http://www.wireless.kth.se/AWSI/

The idea is to have a company that acts as the aggregator of all available access and helps to set up local access companies like the phone ladies or the internet kiosks of Grameen. The access aggregator should be able to integrate several types of networks as long as they are IP networks. The access aggregator should also facilitate easy connection to the core network. In this way many already available resources and networks could be used to build up a network with a far larger reach in a very cost efficient way and provide a business to many local access companies.

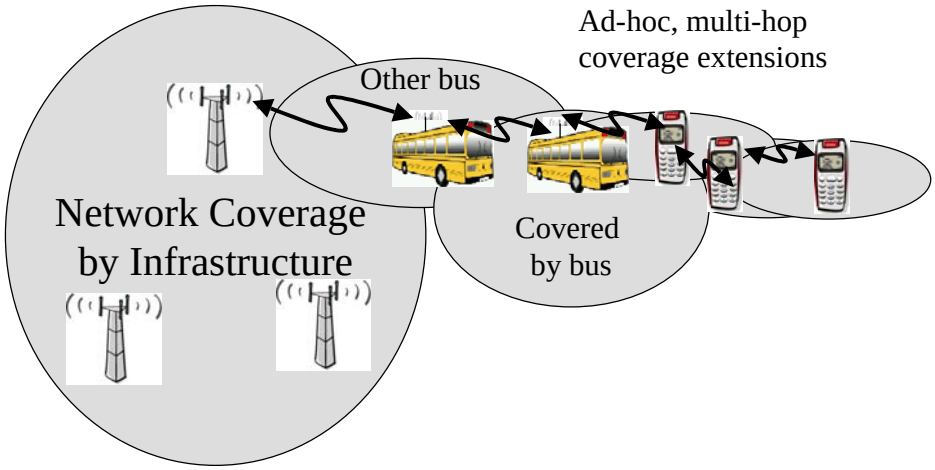

Figure 1 This picture shows the use of several networks and resources to get access. "Ambient Networks Scenarios".
Ohlman B. (ed). IST Ambient Networks. Report 1-1. IST-2002-507134-AN/WP1/R11. 04/2004

Figure 1 shows in a very conceptual way how access to the core network can be reached through the help of devices acting as repeaters and e.g. busses helping to close connections between network nodes. The picture shows telephone devices but in principle the Ambient Networks are meant to be IP networks that could carry data as well as voice.

LinkNet[6]

LinkNet is a project in Zambia with a similar approach to providing ICT infrastructure to rural areas as described in this plan. LinkNet has a clear plan for scaling up from the first proof of concept to national level. LinkNet and TNO have found each other and TNO is now helping LinkNet in the proof of reproduction.

For areas that have no communications infrastructure, LinkNet will improve the future of rural areas in Zambia by providing telecommunications with internet. The key idea is simple, take sea containers normally used for shipping goods, fill them with necessary and pre-installed technology, place them in a rural area and then using wireless technologies to connect them to the internet. VSAT is the technology used, meaning Very Small Aperture Terminal which is an earthbound station that communicates with a satellite. This simple solution bypasses the need for massive (and long term) investments in copper wires or glass fibres and does not need mobile phone masts. However VSAT is still expensive and a the moment the only way to connect to the internet from Zambia. LinkNet plans to take initially small but feasible steps, and then subsequently larger steps. LinkNet has already rolled out its first 'proof of concept' technologies in rural Macha, in the Southern Province of Zambia.

Five key elements of success for LinkNet:
1. Holistic approach involving health institutions, schools and community members;
2. Training of local people for daily operations and onsite support;
3. Packaging the technology in the LinkNet Resource Container;

[6] http://www.link.net.zm

4. Central training and implementation at the LinkNet Centre of Experience at Macha.
5. Maintenance is done by and for local people.

Figure 2 The LinkNet Resource Container

The LinkNet Resource Container concept caters for robust and sustainable performance. Installing off the shelf solutions in rural areas carries a great risk of failure. In fact, studies have shown that 75% of communications facilities like Internet Café's in rural areas have stopped functioning within two years! For this reason all hard- and software used for LinkNet configurations are preconfigured and wired at the production site at Macha. Pre-installing and pre-testing hard- and software will ensure immediate functionality. The LinkNet Resource Container is rented out, tuned for the specific requirements of the rural LinkNet members.
Maintenance, and upgrading of hard- and software, and management of service will be coordinated from Macha, taking technical hassle as much away from users as possible. The LinkNet Resource Container is basically a sea container that hosts:
· VSAT for satellite connection to the Internet;
· If needed, solar powered power supply;
· Wireless Local Area Network for connection of the user PC's;
· Network Server for network services, control, and management;
· Communications tools and PC's for training and community purposes.

CommCase

FOKUS (Fraunhofer Institute for Open Communication Systems)[7] has developed a product called CommCase that could be an important part in low cost networking. Small, compact CommCase boxes equipped with sensors and antennas can form an ad hoc or mesh network, ensuring communication between themselves and with an in-range communication node like a satellite.

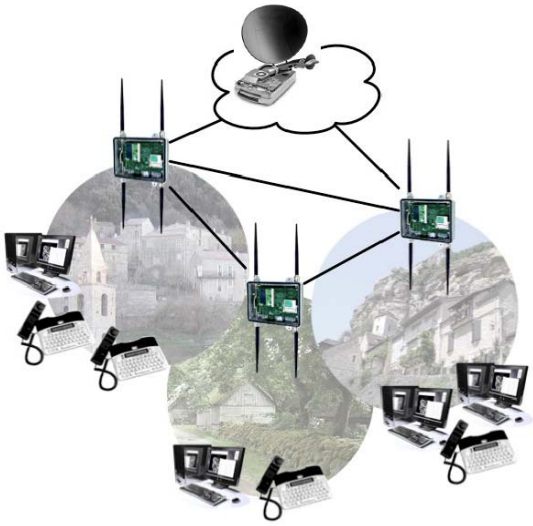

Figure 3 The CommCase concept visualized with a satellite hook-up, then three CommCase boxes that connect several terminals and phones.

[7] Fraunhofer is a W3C member and host of the German/Austrian W3C office http://www.fokus.fraunhofer.de/home/

CommCase boxes are designed for autonomous setup, low power usage and can operate under extreme conditions. They can operate mains-independent, for instance on solar power. In theory combining CommCase with the 'internet in a container' concept of LinkNet could mean that the core connection from the container can be extended by using autonomous CommCase nodes to provide a local network not only around the container but even connections to other villages. It might even be possible to reduce the whole container to a CommCase box. Theory however is of limited value, we need to do it.

Proposal to develop this concept

TNO, LinkNet, FOKUS and the Global Research Alliance[8] pursue this plan to become reality. Combine the best practises as shown in this paper to make a plan for scaling up ICT infrastructure developments in developing countries. Provide support to promising initiatives and learn more by doing.
With al this knowledge and experience make a multi-disciplinary plan to provide complete countries with internet access. Such a plan should at least combine the following topics of: needs assessment, technology development, implement the necessary legislation, provide business cases and develop the required skills and organisational talent to maintain and manage these infrastructures.
It might be a good idea to adopt a pilot country that is willing to cooperate. Then the already available resources should be analysed as well as the needs and requirements for different applications.
With that information the concept of heterogeneous networks that has been invented for the future should be adapted to work with present day technology. Not only theoretically but it has to be shown in practise as well and at really low costs.
If there is a go on the technical feasibility a plan to implement this in the pilot nation should be made and calculated. A practical plan for setting up local access provider businesses should be developed as well. All of this should result in a roadmap towards a nationwide IP infrastructure within 10 years.
Next to the technical development and economic plan for the infrastructure the legal side should be developed to have the laws to complement the innovations and provide room for further development (privacy, network access, business permits, security, recognised schooling and diploma's, etc).
Next to the business plan for the infrastructure it should be made more clear what the potential benefits on a larger scale would be once a nationwide infrastructure is available to all.

This multi-disciplinary approach should result in actions that lead to the realisation of nationwide ICT infrastructures as well as a script for others to follow.

What could you contribute?

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[8] http://www.research-alliance.net