Rural Wireless Connectivity - Timbaktu Experiment

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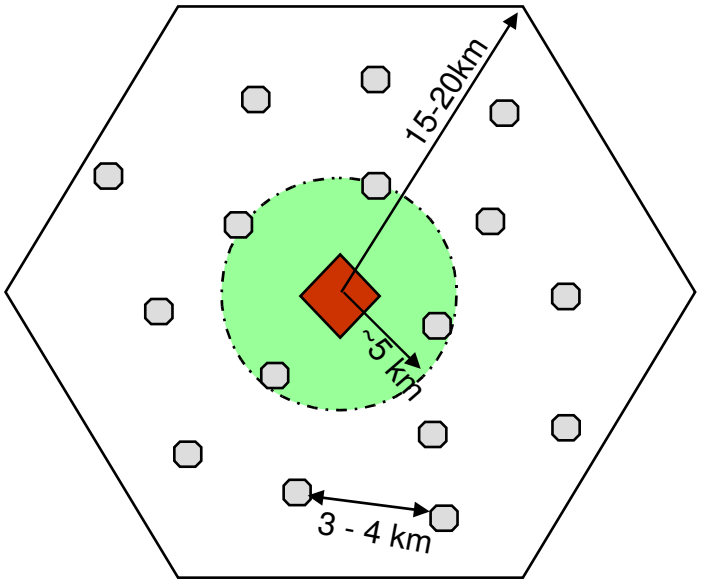
Rural India : Background



Fiber PoP

village

Cellular coverage

- 250-300 villages per PoP

Background

- Each village: average 250 households
- Internet services viable through public kiosks
  - Ref: Work by TeNeT group at IIT Madras (www.tenet.res.in)
- Attempts to increase reach using long-haul wireless links
  - WiMAX – Still expensive
  - WiFi - Spectrum is free; Equipment cost is low
  - Ref: Work by CEWiT to develop modified MAC (www.cewit.org.in)
- Question:
  - What about intra-village connectivity?
  - Can we use WiFi to reach from the kiosk to the homes?

Timbaktu Collective

- Rural NGO setting
  - One old BSNL telephone line
  - Poles get stolen periodically
  - No further landlines possible due to railway track
  - No cellular coverage due to hills around
  - No towers permitted on hills due to being reserved forest
- Problem:
  - Each time there is an incoming phone call, somebody has to run to call the person to the phone
  - Distance between various buildings (kitchen, school, homes) is about 100m average

Experiment Objective

- Can we use off-the-shelf VoIP and WiFi equipment to establish low-cost internal connectivity?

1. Communication within Timbaktu (rLAN)
2. Interfacing with the landline

- Later generalize to other rural scenarios?

Experimenters

- PhD Students:
  - Srinath Perur
  - Raghuraman Rangarajan
  - Sameer Sahasrabuddhe
- MTech Students:
  - Janak Chandrana
  - Sravana Kumar
  - Ranjith Kumar
  - Moniphal Say
  - Annanda Rath

The Equipment (Hardware)

The Equipment (Software)

- Netstumbler
  - For signal strength measurements
- Ping
  - For round trip delay and packet loss measurements
- Netmeeting; SJ Phone
  - VoIP clients for actual testing
- Simputer VoIP client
  - SIP based VoIP connectivity
- Asterisk
  - Software exchange

Theoretical Solution

- Very Easy ☺

1. Put an Access Point (AP), with a directional antenna on top of the highest structure
2. Put additional APs here and there to extend the range of coverage, if required
3. Run Asterisk (software exchange) on an low-end PC and connect it to the landline
4. Configure the VoIP and WiFi on other devices properly
5. DONE

- In reality, it is not so simple.

Environment Complicators

- Power Supply Issues
  - Timbaktu has only Solar power; mostly D/C.
  - Off-the-Shelf APs, PCs, etc. have A/C power plugs.
  - Naïve solution (as outlined earlier) is not useful
  - Only one place had an inverter for A.C. power points (school bldg) => Location of AP determined by default!
- Cable Issues
  - Antenna cable loss
  - Ethernet cable required for connecting phone adapter or PC to AP

- Radio Issues
  - Attenuation by Haystack!
  - Insect mesh on windows
  - Assymmetric transmit power of AP versus client devices

The Setup

Testing – 1 (VoIP over WiFi using Laptops)

Findings – 1 (VoIP over WiFi using Laptops)

- Easily done
  - Works as expected, similar to preliminary testing at IITB.
- Decent signal strength; ping and VoIP results

- Plus pts: Easy to configure Netmeeting; SJ Phone
  - Asterisk server can be eliminated using peer-2-peer mode
- Minus pts: Not practical for following (obvious) reasons:
  - Users are comfortable with phone instruments
  - Laptop needs to be always on just in case there is a call
  - Not convenient to carry around
  - Too expensive

Testing – 2 (Simputers and phone Adapter)

Findings – 2 (Simputers and phone Adapter)

- Do-able with some difficulty

- Signal strength; ping and VoIP results are significantly different from those using Laptops
- Unacceptable delays on the Simputer
- Needs Asterisk server for interconnection
- Not practical from a cost perspective

Technology Transfer

- Continued field tests
- Timbaktu students trained in taking signal strength measurements, VoIP usage trails under various conditions

Cost of Current Solution

- Access Point –
- Antenna –

- Simputer –
  - (one per mobile user)
  - Cost can be amortized by also using it as an educational tool in the school
- Phone Adapter
  - (one per location)
- Phone -
  - (one per location)

Learnings (obvious in retrospect)

- Theoretical assumptions regarding ‘ease’ of setup and configuration are misleading
  - Took quite some time to get everything going (even after preliminary work)
- Environment issues have to be handled afresh each time
  - Scenario for one village may be quite different from another

- Asymmetric transmission capabilities of the access point and client devices is a major issue
  - Seeing a good signal strength from the access point does not imply that VoIP (or even ping) tests would be successful

Suggested Solution

- Access Point and Directional Antenna on School bldg
  - Or wherever there is A.C. power supply
- Standard Phone and VoIP Adapter in each residence
  - Need to find a D.C powered Voice to VoIP over **WiFi** adapter
  - A.C. powered Voice to VoIP over Ethernet adapters available commercially will require an AP on each bldg also!
- Low-power, low-cost device running Asterisk to be connected somewhere in the network
- PSTN to VoIP over WiFi adapter at the landline interface
- Cost of solution ?

Conclusion

- VoIP over WiFi seems to be a viable alternative for providing internal communication within a village
- Next phase of experiment will involve interfacing the rLAN to the external world through appropriate adapters
  - PSTN line
  - Cellular
  - WiFiRe
- Cost of equipment is not the main factor for low cost solutions. Availability of power and terrain are main issues
  - Need to adapt devices for low-power (D.C) also

Comments?