

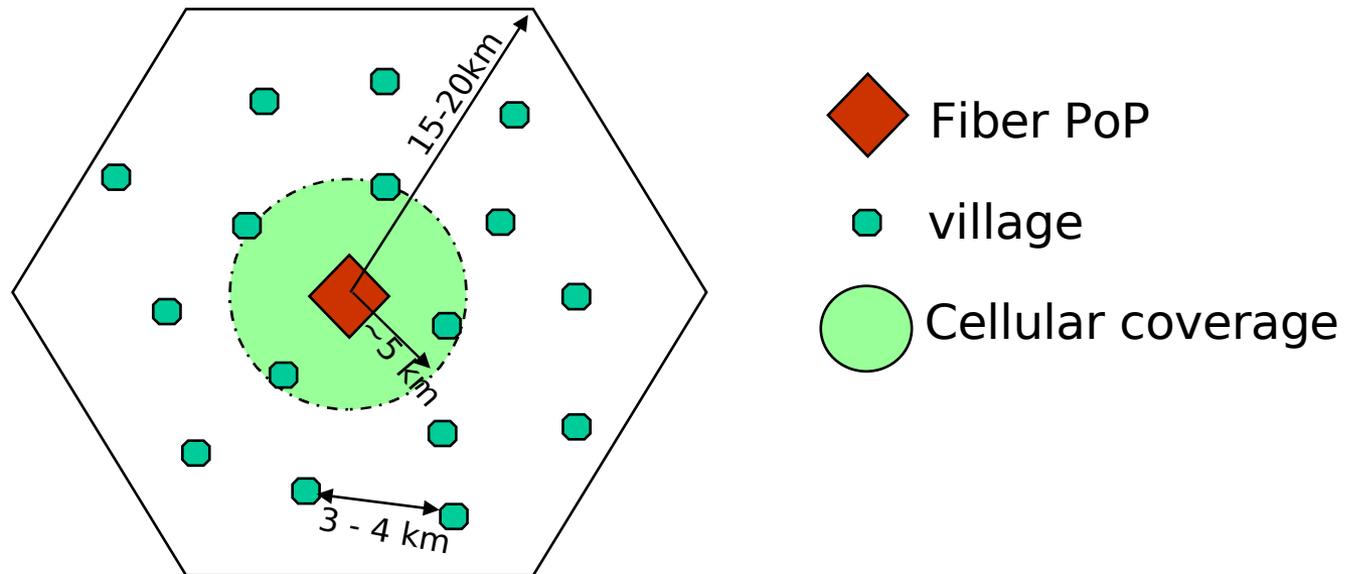
# Multi-Tier Networks for Rural Connectivity

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# Rural India : Background



- 250-300 villages per PoP
- Each village: avg 250 households

85% of the villages have one public telephone

# Background

- Issues with fixed and cellular telephony
  - Infrastructure establishment and maintenance
  - Investment recovery
- Attempts to increase connectivity using long-haul wireless links
  - corDECT – kiosk model (TeNeT, IIT Madras).
  - WiMAX – Still expensive.
- Can we use WiFi?
  - Spectrum is free; Equipment cost is low.

# WiFi based long-haul connectivity

- DGP Project – IIT Kanpur
  - Established the possibility of long-haul links.
  - DCF/PCF MAC not suitable.
- 2P MAC protocol – IIT Kanpur
  - Modification for Mesh networks using point-to-point links.
- WiFiRE – CEWiT (IITM, IITB, IITK, IISc)
  - Modification for Star Topology.
  - One-liner: WiMAX-like MAC over a WiFi PHY.
  - Key differences: Single channel; Multi-sector.

# Telecommunication within villages

- Can we do more than just 'connect' the village?
  - Given one communication line that reaches the village, by wired/wireless means,
- Questions:
  - Can we use WiFi to reach from the kiosk to the homes?
  - Can we use multi-hop wireless networks?
- Experiment with some students: Timbaktu

# 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?
- 3. Communication within Timbaktu (rLAN)
- 4. 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

## ■ Timbaktu Video

- (play from 2:35 to 5:05)

# The Equipment (Hardware)



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# 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

# Theoretical Solution

- Very Easy 😊
- 3. Put an Access Point (AP), with a directional antenna on top of the highest structure
- 4. Put additional APs here and there to extend the range of coverage, if required
- 5. Run Asterisk (software exchange) on an low-end PC and connect it to the landline
- 6. Configure the VoIP and WiFi on other devices properly
- 7. 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
  - Device OS constraints may be a problem
  - Device cost may be an issue
- Needs Asterisk server for interconnection

# Testing – 3 (Interfacing to the LandLine)

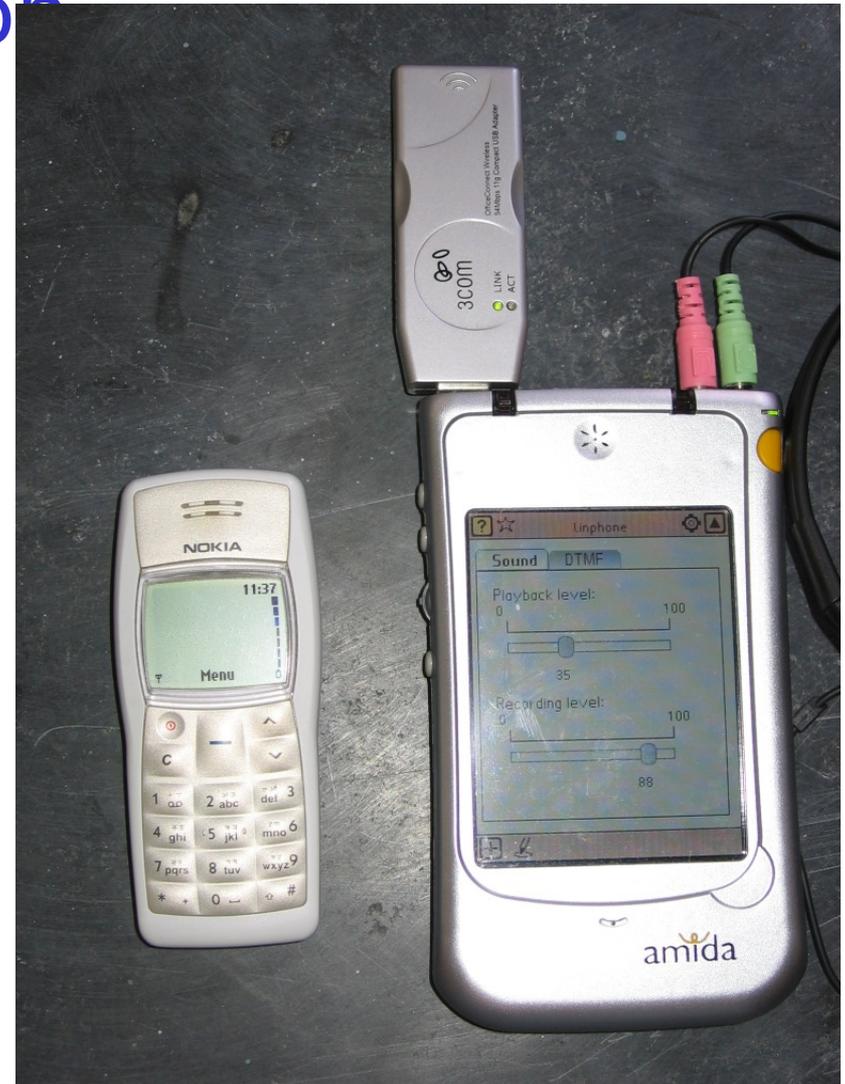


## Findings – 3 (Interfacing to the Landline)

- Reasonably straightforward exercise.
- Device (Sipura) and Software PBX (Asterisk) can be configured to provide IVR, 'internal' extension numbers, like using a EPABX.
- Feasible and affordable solution.
  - Timbaktu people are using it !!
- Solution is applicable to many Indian villages.
- Opportunity for rural entrepreneurs.

# Cost of Current Solutions

- Access Point –
- Antenna –
- Simputers –
  - (one per mobile user)
  - Cost can be amortized by also using it as an educational tool in the school
- Phone Adapters
  - (one per location)
- Phones -
  - (one per location)



# Technology Transfer



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

# 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

